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## THE BUILDING OF "CORAL" REEFS

A coral reef is a ridge or mound of limestone, the upper surface of which lies or lay at the time of its formation, near the level of the sea, and is predominantly composed of calcium carbonate secreted by organisms, of which the most important are corals.

THE above is the opening sentence of an able and suggestive paper by Dr. Thomas Wayland Vaughan on "Physical Conditions under which Paleozoic Coral Reefs were formed," published last year in the *Bulletin of the Geological Society of America.*[1] If we pass over for the moment the question as to just what is meant by "near the level of the sea," a point that is discussed by Dr. Vaughan later on, the part of the above definition that particularly challenges attention is the final clause, "of which the most important are corals." It is not to be denied that this last statement embodies the long-standing and still prevalent view as to the origin and composition of coral reefs and, in fact, it might seem at first sight to be quite axiomatic that corals should be the most important constructive agents in the formation of "coral" reefs. But in view of the fact that some rather recent studies indicate that lime-secreting plants have been much more important than the corals in the formation of certain "true coral reefs" and in view of the few borings and analytical studies of so-called "coral" reefs thus far made, there would seem to be sufficient ground for contending that the whole question as to the relative general importance of lime-secreting animals and lime-secreting plants in the formation of reefs is still an open one. From

[1] Vol. 22, p. 238.

what may be observed to-day in the tropics as to the relative abundance of calcareous marine plants and calcareous marine animals and from what has been determined by the study of the cores obtained by boring into coral reefs, it would appear that sometimes the plants predominate and sometimes the animals. As Dr. Vaughan points out, there are good grounds for believing that the conditions attending the formation of coral reefs in ancient times were not very different from those that prevail at present. In any event, the definition quoted above is intended to be a general one and its validity is to be tested by application to recent and modern conditions as well as to those of long-past geological ages.

The best-known example of a thorough and detailed study of the nature of a coral reef is embodied in a quarto work of more than four hundred pages published by the Royal Society of London in 1904 and entitled "The Atoll of Funafuti: Borings into a Coral Reef and its Results: Being the Report of the Coral Reef Committee of the Royal Society." Funafuti was selected for this study because it was considered a "typical" coral reef or island. Several borings were made by members of the three successive expeditions that visited the atoll, the first attempts being only partially successful, and the cores thus obtained were brought back to England for careful study. The main boring was finally driven down to a depth of 1,114½ feet. *Lithothamnion,* a hard stone-like red coralline seaweed, of the group commonly known to zoologists and geologists as "nullipores," was found to be more or less abundant through the entire length of the boring; *Halimeda,* a calcified green seaweed, was locally very abundant from 28 to 1,096 feet in depth. Professor J. W. Judd sums up the general results of the analysis of the cores as follows:

> Dr. Hinde's carefully drawn up lists show that from top to bottom the same organisms occur, sometimes plants, sometimes foraminifera, and sometimes corals predominating (p. 174).

It is to be observed that he mentions plants first. Moreover, Mr. A. E. Finckh, who was one of the members of the expedition and wrote the chapter on "Biology of Reef-forming Organisms at Funafuti Atoll," definitely groups these organisms in order of their reef-building importance as follows: "(1) *Lithothamnion;* (2) *Halimeda;* (3) the Foraminifera; (4) the Corals." It will be noted that the first two places in this ranking are given to members of the plant kingdom and that the corals, the "most important" reef-building organisms of Vaughan's definition and of the still prevalent popular belief, are relegated to a fourth position. This naturally raises the somewhat academic, though chiefly biologic, question, "When is a 'true coral reef' not a coral reef?" It raises also a serious question as to whether the continued use of "coral" reef for structures that have been built up largely through the agency of plants is not responsible for false ideas and widespread mental confusion.

That the opinion of Mr. Finckh in regard to Funafuti is not his alone, is evident from the following statement by J. Stanley Gardiner, who, being a professor of zoology in Cambridge University, should be free from any suspicion of bias in favor of the plants:

> The reef [of Funafuti] seems to have been mainly formed by the growth of nullipores, which are now building up masses outside the rim and adding them on the reef, causing its extension seawards.[2]

[2] "The Coral Reefs of Funafuti, Rotuma and Fiji, together with some Notes on the Structure

Incidentally, for the benefit of botanists, who have long abandoned the term "nullipore," even though the enforcement of priority principles in nomenclature may possibly lead to its revival, it may be explained that the generic name *Nullipora*, as proposed by Lamarck in 1801, was made to include four species of calcareous organisms believed by him to be animals, but all of which, probably, were plants and members of the family Corallinaceæ of the red algæ—the family popularly known as the "coralline seaweeds." Furthermore, they were of the subgroup sometimes spoken of as the "unsegmented" corallines, including the numerous forms that until recently have passed under the widely inclusive generic name *Lithothamnion*, but now commonly segregated into smaller generic groups known as *Lithothamnion*, *Lithophyllum*, *Goniolithon*, *Phymatolithon*, etc. But the term "nullipore," which has remained the almost exclusive possession of the zoologists and geologists, while applied chiefly and properly to the stone-like or coral-like red algæ, has occasionally been made to cover also undoubted animals and was used by Alexander Agassiz[3] to include also some of the very different calcified green algæ. Alexander Agassiz, by the way, was one of the first to emphasize the importance of "nullipores" in reef-building, but the loose way in which he frequently referred to "nullipores and algæ," "corallines and algæ" may easily have hidden from many of his non-botanical readers the fact that his "nullipores" and "corallines" were just as truly algæ as are any of the species of *Fucus*.

But, to return to our main subject, there is considerable evidence that the dominance of plants in building up the "true coral island" Funafuti is not an exceptional or isolated instance of their activity in this direction. Professor Gardiner, in describing the reefs of Fiji, in the paper referred to above, says:

> The parts of "compact homogeneous texture" are very numerous and are formed, I believe, mainly by carbonate of lime secreted by incrusting nullipores. The importance of the incrusting nullipores, in the formation of the reefs of the Central Pacific can not be overestimated.[4]

Again,[5] in discussing the foundation of atolls in general, Professor Gardiner remarks that

> The chief building organism is *Lithothamnion*, the bathymetrical zone of which must be limited to a large degree by the extent to which light can penetrate seawater.

In another case,

> This nullipore [*Lithophyllum craspedium*], Finckh says, is actually the reef-former at Onoatoa [Gilbert Islands]. He saw no live coral there, but everywhere on the lagoon and ocean-face immense masses of this particular nullipore.[6]

That lime-secreting plants rather than corals are sometimes, at least, the dominant reef-formers in the Indian Ocean as well as the Pacific, is shown by the following remark by Professor Gardiner:

> The reefs of the Chagos are in no way peculiar, save in their extraordinary paucity of animal life. . . . However, this barrenness is amply compensated for by the enormous quantity of nullipores (*Lithothamnia*, etc.) incrusting, massive, mammillated, columnar and branching. The outgrowing seaward edges of the reefs are practically formed by their growths and it is not too much to say that, were it not for the abundance and large masses of these organisms, there would be no atolls with surface reefs in the Chagos.[7]

and Formation of Coral Reefs in General," *Proc. Camb. Philos. Soc.*, Vol. 9, pp. 417–503, 1898.

[3] *Bull. Mus. Comp. Zool. Harv. Coll.*, Vol. 14, p. 82, 1888.

[4] *Loc. cit.*, p. 477.

[5] *Loc. cit.*, p. 501.

[6] "Fauna and Geography of the Maldive and Laccadive Archipelagoes," Vol. I., p. 462.

[7] *Trans. Linn. Soc. London*, Zool., 2d ser., Vol. 12, pp. 177, 178, 1907. Also, *Nature*, Vol. 72, pp. 571, 572, where a photograph of this *Lithothamnion* reef is published.

That the coralline algæ form extensive banks and reefs in the Dutch East Indies also is indicated by the following quotation from Mme. A. Weber-van Bosse's report on "The Corallinaceæ of the Siboga Expedition":[8]

> Near the coast of Haingsisi, an island near the S. W. point of Timor, the Siboga anchored twice . . .; the second time good luck favoured us, it was springtide, the water sank very low and we could observe that the whole reef . . . consisted chiefly of *Lithothamnion erubescens* f. *Haingsisiana*. It was remarkable that the branching knolls remained quite dry during several hours of the day, exposed to the glare of the tropical sun, and that this seemed not to injure them. . . . This *Lithothamnion*-bank struck me, because it is such a unique sight to see the ground, as far as the eye can reach, covered by the pretty beautifully pink-coloured knolls, which are heaped up so close together that, while walking, one crushes them continually, making a peculiar noise as of broken china. We encountered, however, other and perhaps more instructive *Lithothamnion* banks during our voyage.

Bermuda, as is generally known, was commonly considered a "true coral" island until the studies of Alexander Agassiz[9] and of Henry B. Bigelow[10] indicated that the corals have played a rather minor part in its upbuilding. Dr. Bigelow believes (*loc. cit.*, p. 582) that "algæ probably form the greatest mass" of what he terms the "shell sands" of Bermuda, and it is of interest to note that Sir John Murray in reporting the results of the *Challenger* Expedition intimates that the calcareous seaweeds and their broken down fragments were the dominating elements in three out of four analyzed samples of so-called "coral" sand or mud from Bermuda. Dr. Bigelow, in connection with his critical studies of "The Shoal-water Deposits of the Bermuda Banks," made a series of dredgings on the Challenger Bank, nine miles or more from Bermuda. His dredge brought up chiefly "calcareous pebbles," which on examination proved to be formed by a species of *Lithothamnion*. These were growing at a depth of from 30–50 fathoms, a depth too great for most of the corals. In summing up the results of these studies, Dr. Bigelow writes:[11]

> The dredgings from the Challenger Bank add to the evidence already accumulated to prove the great importance of the nullipores as reef builders. . . . This process taking place over the Challenger Bank, where there is no direct evidence of either elevation or subsidence, has raised it to within some thirty to fifty fathoms of the surface of the sea, a depth where a few corals already flourish. If we imagine this process as continuing until the bank rises to within about twenty fathoms of the surface, we should then have excellent conditions for the formation of a coral reef. Of course in such upbuilding the nullipores constitute only a part, though a most important one, of the whole growth.

It would appear from this observation of Dr. Bigelow's and from various other records that the lime-secreting seaweeds flourish and are effective reef-builders in greater depths than is the case with the corals. Dr. Vaughan, in the paper under discussion, quotes Professor J. Stanley Gardiner as authority for the statement that the "nullipores extend to a depth of 35 fathoms" in the Maldives, but Mr. A. E. Finckh in his dredging operations about Funafuti frequently found them in "depths of over 100 fathoms *in situ*"[12] and also found *Halimeda* alive down to 45 fathoms. From Alexander Agassiz's description of the Pourtalès Plateau off the southern coast of Florida, one seems justified in inferring that he found incrusting

[8] "Siboga-Expeditie," Monographe LXI., p. 4, 1904. Interesting photographs of the *Lithothamnion* bank are here published.

[9] *Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. 26, pp. 205–281, 1895.

[10] *Proc. Am. Acad. Arts and Sci.*, Vol. 40, pp. 557–592, 744, 1905.

[11] *Loc. cit.*, pp. 589, 590.

[12] "The Atoll of Funafuti," p. 134.

"nullipores" in a living condition at depths of from 250 to 350 fathoms.[13] According to Dr. Vaughan, it is generally conceded "that 25 fathoms is the greatest depth" at which the reef-building corals work effectively, "although an occasional reef species may extend downward to a depth of 40 fathoms."

Besides flourishing in greater depths than the corals, the lime-secreting seaweeds are much less dependent upon high temperatures than are the corals. Sir John Murray has remarked[14] that "in the polar seas and in the cold water of the deep seas there is, as is well known, a feeble development of all carbonate of lime structures in marine organisms," a statement that may be true enough in a comparative way for organic nature as a whole, but is manifestly much more true of the corals than of the coral-like red algæ. The coralline algæ are, locally at least, abundant from 73½° south latitude[15] to 79° 56′ north latitude.[16] The late Professor Kjellman, of Upsala, has stated[17] that off the coasts of Spitzbergen and Nova Zembla *Lithothamnion glaciale* "covers the bottom in deep layers for several miles" mostly in 10 to 20 fathoms of water, and he adds that "in the formation of future strata of the earth's crust in these regions it must become of essential importance." Another species of *Lithothamnion* is said to form banks on the coasts of Iceland and of Greenland. Foslie[18] states also that

> North of the polar circle on the coast of Norway banks have been met with which cover the bottom for several miles and plants appear in immense masses, frequently representing only one species.

A good account of "Algæ as Rock-building Organisms," with special reference to their occurrence in ancient limestones, was contributed to *Science Progress*[19] in 1894 by Professor A. C. Seward, of Cambridge University. An interesting feature of Professor Seward's paper is his summary of the results of J. Walther's studies of a *Lithothamnion* bank in the Bay of Naples about 30 m. below the surface of the water:

> By action of the percolating water the *Lithothamnion* structure is gradually obliterated, and the calcareous mass becomes a structureless limestone. Walther applies his knowledge of this recent algal deposit to the examination of a Tertiary "Nulliporenkalk" near Syracuse. In many parts of this formation there occur well-preserved specimens of *Lithothamnion*, but in others a gradual obliteration is observed of all plant structures until the rock becomes entirely structureless. A similar instance of structureless limestone is described from the Lias of Todten Gebirges [Todtes Gebirge].

In Bermuda, southern Florida and the West Indies one finds among the living reef-building organisms and in their distribution and association many of the general types described by Gardiner and others for the Pacific and Indian oceans, even though "true atolls" of the Pacific type may be rare or quite wanting. There are banks and reefs that appear to consist almost wholly of calcareous plants others that are almost "pure stands" of corals, and yet others where these two elements are intermingled. In the last case, the "nullipores" often seem to be overgrowing and smothering the corals, as has been observed in the Pacific and elsewhere. In view of all of the evidence now available it would be a bold man who would venture to say

[13] *Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. 14, p. 287, 1888.

[14] *Natural Science*, Vol. 11, p. 26, 1897.

[15] Foslie, M., "Corallinaceæ, in National Antarctic Expedition, Natural History," Vol. 3, 1907.

[16] Kjellman, F. R., "The Algæ of the Arctic Sea," *Kongl. Sv. Vet.-Akad. Handl.*, Vol. 20, No. 5, p. 96, 1883.

[17] Kjellman, *loc. cit.*

[18] In Gardiner, "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," Vol. 1, p. 462.

[19] Vol. 2, pp. 10–26.

that the corals are secreting and depositing any more calcium carbonate in the West Indian region than are the calcareous algæ. The massive beds of *Halimeda opuntia* off the Florida Keys (the same species, by the way, that is filling the lagoons of some of the South Sea atolls) are striking, as are the banks of *Goniolithon strictum* in the Bahamas and reefs of *Lithophyllum Antillarum* and *Lithophyllum daedaleum* along the shores of Porto Rico, yet probably none of these are so conspicuous and massive as are certain local aggregations of living corals in the same general regions. However, the lime-secreting plants appear to be much more generally and widely distributed, both horizontally and vertically, than are the corals, and the rate of growth is, of course, a factor of importance in any attempt to estimate the relative lime-depositing activity of corals and calcareous algæ. The notable studies and measurements of living corals by Dr. Vaughan at the Tortugas station of the Department of Marine Biology of the Carnegie Institution of Washington are beginning to throw a most welcome light on the rate of growth of the corals. No similar records of the rate of growth of the calcareous red algæ have as yet been published, so far as we are aware, but from the fact that these plants often cover and smother living corals one is perhaps justified in assuming that the growth of certain kinds of coralline algæ is superficially, at least, more rapid than that of certain kinds of corals. For the rate of growth of the calcareous green algæ we have scarcely any definite records except one by Finckh,[20] who observed in Funafuti a radio-vertical growth of three inches in six weeks in a tangle of *Halimeda opuntia* that had found its way through a hole in a board. This growth-rate, which is possibly more than a fair general average for the species, seems much more rapid than any thus far attributed to the corals.

With the dominance in reef-building activities resting sometimes with the calcareous algæ and sometimes with the corals, and with the Foraminifera and other groups also playing their parts, the problem of determining the "most important" constructive element in the calcium carbonate reefs of the world, ancient and modern, is naturally a most complicated and difficult one and one that may never be solved to the full satisfaction of those most interested. Alexander Agassiz, in 1894, in summing up the general result of his explorations of Bermuda and the Bahamas, which had revealed a condition of things not realized before, frankly remarked that it was a "significant example of how little we as yet know of the history of the formation of the coral reefs."[21] As a general proposition this remark seems almost as apt now as when it was made in 1894. However, since the day of the first illuminating borings into the "true coral atoll" of Funafuti, much evidence has accumulated tending to show that the importance of the corals in reef-building has been much over-estimated and that the final honors in this connection may yet go to the more humble lime-secreting plants.

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[20] "The Atoll of Funafuti," p. 146.

[21] *Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. 26, p. 278.

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## *UNIVERSITY CONTROL*

### II

In a review of the different factors concerned with the administration of a university the corporation in ultimate control is the natural starting-point. It was becoming that the fellows of Yale College, a collegiate school primarily for the education of the clergy, should be representative

clergymen of the state. In general the trustees of the primitive American college were competent to administer its simple economy. But even then there were difficulties. Before the American Institute of Instruction meeting in Worcester, Mass., in 1837, the Rev. Jasper Adams, president of Charleston College, gave a lecture on "The relations subsisting between the board of trustees and the faculty of the university," stating that as far as he knew this had never been the subject of special investigation. He argues that the trustees should manage the funds of their institution, while the faculty should regulate the courses of instruction and the internal administration. Professors should be appointed by the trustees on the advice of and in accordance with the wishes of the faculty. It appears that in those days there was trouble through the trustees interfering with what the faculties regarded as their rights, notably at Hamilton College, concerning which the president wrote a pamphlet entitled "A Narrative of the Embarrassments and Decline of Hamilton College," which he attributed to meddling by the trustees with the business of the faculty. At that time President Adams and President Davis seem to have regarded themselves as professors rather than as trustees. According to President Adams:

> More than one board of trustees has ruined, and every board will ruin its college, which shall interfere with the province rendered appropriate to the faculty by the peculiar skill, knowledge and experience which their education, greater attention to the subject, and practical opportunities, have naturally, and as a matter of course, given them. . . . Many a faculty of a college, who felt themselves qualified, not only to sustain their institution, but to raise it to usefulness and renown, and gain for it the favor, confidence and patronage of the public, have found all their efforts discouraged, embarrassed and finally defeated by the conduct of their board of trustees. Plans of improvement, after having been matured by much labor and careful consideration, have been presented for acceptance and approbation, only to be retained with coldness and indifference, treated with neglect and finally rejected, after a hasty examination, for want of a competency to understand them. Favorable times and seasons have been permitted to pass by unimproved, and have been lost never to return, because the faculty had not power to act on the subject, and the trustees could not be induced to seize the favorable moment, and turn the occasion to the benefit of the institution. Under these circumstances, the faculty have been compelled to remain inactive, and let things take their course, or to resign their office in discouragement and disgust. In either case, the institution has been ruined.

The legal powers of trustees and regents are similar everywhere, but their actual part in the conduct of the institution varies greatly. It is likely to be larger when the board is small and when the members reside near by. In his Harris lectures on "University Administration" President Eliot says: "The best number of members for a university's principal board is seven," and with pleasing naïveté he adds a little later: "It is a curious fact that the university with the most fortunate organization in the country is the oldest university, the principal governing board, the President and Fellows of Harvard College, consisting of seven men." When the board of trustees is large and meets but rarely, there is usually an executive committee which with the president is in substantial control. The members of this committee are likely to be the friends and adherents of the president—in practise the president is likely to select the trustees and the members of their executive committee —and the faculties and professors are supposed to communicate with the trustees only through the president. Under our existing system, there should be an elected committee of the faculties which would meet with the executive committee of the trustees. It would in addition be advis-

able to permit the professors and other officers to elect for limited terms representatives—not necessarily from among themselves—on the board of trustees in the manner now becoming usual for alumni representation. It is undesirable for the individual professor to tease the trustees with his needs or grievances; but there should surely be some way by which trustees and professors can consider together the problems confronting the university. A joint committee of trustees and professors such as has just now been constituted to administer the Crocker Cancer Research Fund of Columbia University is an excellent plan.

If trustees are trustees and not directors, it does not greatly matter in practise how many of them there are or how they are chosen, so long as they are men of integrity and honor, representative of the common sense of the community. Even if the trusteeship is an acknowledgment of gifts made or hoped for, no great harm is done. But a self-perpetuating board with absolute powers, even though for a generation the powers may not be abused or even used, is intolerable in a democratic community. The president and directors of industrial corporations are elected by the shareholders and are increasingly supervised by the state. In the state universities the regents are elected by the people or appointed by their representatives, and the people may be regarded as the ultimate corporation. In the case of the private universities, it would apparently be wise to have a large corporation consisting of the professors and other officers of the university, the alumni who maintain their interest in the institution and members of the community who ally themselves with it. This corporation—or perhaps better the three groups of which it is composed—should elect the trustees. Thus there might be a board of nine trustees, one being elected annually for a three-year period by each of the three divisions of the corporation.

Several of my correspondents hold that the members of the community permitted to join the corporation of a university should be carefully selected. I should myself like to see the widest possible participation. If 10,000 or 50,000 people would join such a corporation, so much the better. They would pay dues, perhaps five or ten dollars a year, and would enjoy certain privileges such as attendance at lectures and concerts, the use of libraries, museums, rooms for meetings and the like. If many people are concerned with their university, it is well for them and for it. Some of them will become seriously interested, ready to aid with their counsel, their influence and their money. In New York City several institutions—the Metropolitan Museum of Art, the American Museum of Natural History, the Zoological Park, the Botanical Garden—are partly supported by the city, partly by boards of trustees and partly by members. The buildings are owned and the curators are paid by the city; the collections are owned and the research work is paid for by the trustees; the members have certain privileges in return for dues. In spite of obvious difficulties, the plan has worked well.

A large corporation holding the university in trust for all the people is clearly a step in the direction of public ownership. It is the ultimate fate of every corporation to be controlled by the state, and our private universities will surely become part of the system of public education. This should develop gradually rather than through such measures as have been required to obtain control of church property in other nations. When the people own their universities they will probably see the wisdom of delegating to those con-

cerned—namely, the officers of the university, its alumni and members of the community taking an interest in higher education and having knowledge of it—the right to elect the trustees. True democracy does not consist of government by the uninformed, but of government by those most competent, selected by and responsible to the people. In one of the leading state universities one third of the trustees are elected by the alumni; a second third might to advantage be elected by the teachers, the remaining third being elected by the people or their representatives.

When trustees in the state universities are elected by the people or their representatives and in the private universities are elected by the corporation consisting of officers of the university, alumni and members of the community, the question as to their powers and duties is perplexing. Much can be said in favor of giving them no more power than is vested in a trust company designated as trustee of an estate, and arguments can be urged in favor of a small paid board of experts having the ultimate decision on all questions. I seem to have been almost the only educational person in the country who approved of the principle of Mayor Gaynor's plan for a small paid board of education for New York City, and I should regard its present adoption as risky. This, however, is the correct method of democracy—experts selected by the people and paid for their work. The professors and other officers of the university should be such. Whether in addition to them it is desirable or necessary to have a board to coordinate and control their work, to regulate their duties and fix their salaries, is a question which can only be settled by experience. Certainly the commission form of government is preferable to an individual autocrat.

In the academic jungle the president is my black beast. I may seem to be in the condition of the animal suffering from the complication of diseases described in a recent issue of a New England paper:

> Patrolman Lindstrum went to East Elm Street recently and shot an alleged mad dog. The dog also was declared to have hydrophobia and rabies.

As a matter of fact neither barking nor biting is warranted. An eminent philosopher of Harvard University in a lecture to a class at Radcliffe is alleged to have depicted in eloquent terms the darkness of the life of him who has lost his religious faith and then to have added that the only compensation is a sense of humor. Whereat first one and then another of the students began to weep until all the eighty girls were in tears. It is more becoming for university professors to appreciate the semi-humorous absurdity of the situation than to fall to weeping together. I once incited one of my children to call her doll Mr. President, on the esoteric ground that he would lie in any position in which he was placed. Of course, the president is by nature as truthful, honorable and kind as the rest of us, and is likely to have more ability or enterprise, or both. But he really finds himself in an impossible situation. His despotism is only tempered by resignation; and in the meanwhile he must act as though he were a statue of himself erected by public subscription. In Tennyson's words:

> Who should be king save him who makes us free.

The argument for giving a free hand to the president is that this is the way to get things done. It should, however, be remembered that it is quite as important—and this holds especially in the university—not to do the wrong thing as it is to do the right thing. The time of the president is largely occupied with trying to correct or to explain the mistakes he has made, and the time of the professor is too much

taken up with trying to dissuade the president from doing unwise things or in making the best of them after they have been done. Administrative details should be attended to promptly and correctly; this is the proper business of secretaries and clerks. Then we need leaders, most of all in a democracy. But in a democracy leaders are the men we follow, not the men who drive us. In the university each should lead in accordance with his ability and character.

The trouble in the case of the university president is that he is not a leader, but a boss. He is selected by and is responsible to a body practically outside the university, which in the private corporations is responsible to nobody. In our political organization, the mayor, governor or president has great power, too great in my opinion, if only because it demoralizes the legislature; but they are responsible to the people who elect them. I object even more to the irresponsibility of the university president than to his excessive powers. The demoralization that the president works in the university is not limited to his own office; it has given us the department-store system, the existing exhibit of sub-bosses—deans, heads of departments, presidential committees, professors appointed by, with salaries determined by, and on occasion dismissed by, the president, all subject to him and dependent on his favor.

It is not my wish to depreciate unfairly the services of the American university president. Like the promoter in business and the boss in politics, he has doubtless been a factor natural and perhaps desirable in a given stage of evolution, when the growth of the complexity of society and the need of new adjustments have outrun the adaptability of the individual. It is probable that the president has increased appropriations and gifts; it is possible that he has promoted rather than hindered the development of the university and the extension of its work. The president, however, has not usually been the cause of gifts, professors and students, but only the means of diverting them from one institution to another, and on occasion of doing so in ways unworthy of the institution which he then misrepresents. The president has not infrequently sacrificed education to the fancied advantage of his own institution. Thus college entrance requirements have imposed studies in the high school which drive from it the majority of boys. The opposition of certain presidents of proprietary universities to a national university is not less pernicious, if it results from honest prejudice. The prestige of the president is due to the growth of the university, not conversely. He is like the icon carried with the Russian army and credited with its victories. President Eliot claimed that he had never asked for a gift for Harvard. During the lean years he was regarded as a poor money-getter; when the fat years came with the increasing wealth of the alumni and of the country, this opinion was reversed, but he had not changed. President Eliot is a truly great man, but his remarks on all sorts of subjects, usually wise but occasionally otherwise, were reported everywhere, not for their wisdom, but on account of his position.

While I regard it as desirable to do what little I can to make ridiculous an institution which has become a nuisance, and while I should find my state of dependence on a president for my opportunity to serve the university intolerable if I concealed my views, I certainly do not wish to be understood as lacking in appreciation of the fine characters and high motives of most of the men who have served

as professors and later become presidents. They do not considerably, if at all, excel in character or ability beyond the average standard of the professorship, but they exploit before the world how high this standard is. The practise of many presidents is a sacrifice of their real convictions to the imagined exigencies of the situation. Most of them would agree that autocracy in the university is undesirable. Thus President Eliot writes:

> The president of a university should never exercise an autocratic or one-man power. He should be often an inventing and animating force, and often a leader; but not a ruler or autocrat. His success will be due more to powers of exposition and persuasion combined with persistent industry, than to any force of will or habit of command. Indeed, one-man power is always objectionable in a university, whether lodged in president, secretary of the trustees, dean or head of department.

Dr. Seelye, then president of Smith College, at the inauguration of Dr. Rhees as president of Rochester University, said:

> Autocracy, however, is a hazardous expedient, and is likely to prove ultimately as pernicious in a college as it is in a state. It induces too great reliance upon the distinctive characteristics of a despot, and too little upon those of a gentleman. One-man power is apt to enfeeble or to alienate those who are subject to it. . . . Successful autocrats are few, and however long their term of service, it is short compared with the life of an institution. If they leave as an inheritance a spirit which has suppressed free inquiry, and which has made it difficult to secure and retain teachers of strong personality, the loss will probably be greater than any apparent gain which may have come through the rapid achievements of a Napoleonic policy.

Under existing conditions—at least in our proprietary universities—it appears that the place which the president now fills, or wobbles about in, might be divided into three parts. There might be a chancellor, as in the English universities, a man of influence and of prominence, representing the corporation and the relations of the institution to the community, concerned with increasing the endowment and prestige of the university. Then there might be a rector, as in the German universities, elected annually or for some other limited period by and from the faculties, presiding at academic functions and the like. In the third place, there would be a secretary or curator, an educational expert in charge of administrative details. In a real democracy and with a people appreciative of the needs and service of the university, the former two officials would become superfluous.

It must be admitted that the situation is difficult. The alumni are no longer predominantly scholars or even professional men. They have more concern for football than for the work of the professor; any university club could get on better without its library than without its bar. But the alumni of a university should be not less intelligent and wise than the electorate of the nation. In both cases the ultimate control must be democratic, unless perchance we are following false gods. Experts and intellectuals are not, as a rule, to be trusted to act for the common good in preference to their personal interests. The professors of an endowed university can not be given the ultimate control. A monastery or a proprietary medical school must ultimately be reformed from without. We need the referendum and the recall because we can not trust those placed in authority, and we fear these measures because we do not trust the people. An aristocracy is deaf; a democracy is blind. But it is our business to do the best we can under the existing conditions of human nature. Advancing democracy has burned its bridges behind it. No one believes that a city should be owned by a small self-perpetuating board of trustees who would appoint a dictator to run it, to decide what

people could live there, what work they must do and what incomes they should have. Why should a university be conducted in that way?

The bible is often misquoted to the effect that "money is the root of all evil." The love of money and the lack of money are indeed factors in most of the difficulties of society. Next after the getting of men, the getting of money for the university is its most troublesome problem, and next after the proper treatment of men, the use of money is the most important question. He who holds the purse strings holds the reins of power. That the president should decide which professor shall be discharged and which have his salary advanced, which department or line of work shall be favored or crippled, is the most sinister side of our present system of university administration, more pernicious in the private universities, where dismissals and salaries are kept secret, than in the state universities, where salaries are published and teachers are, or should be, dismissed, as in the better public-school systems, only after definite charges.

To transfer the control of appointments and finances from the president to the professors would strike many as passing from purgatory to a worse place. A university executive said to me the other day that if the professors were in control the first thing that they would do would be to raise their own salaries. Well, perhaps worse things have been done. It may be admitted that this is what a president usually does for himself and to an extent beyond the dreams of the most avaricious professor. But there are at least two points of difference. First, the president may increase his salary by withholding a small sum from each professor, whereas the professors could only increase their salaries by obtaining the money for the purpose. Second, it is undesirable for a president to receive three or four times the salary of the greatest scholar or teacher on the faculty, as is the case at California, Columbia and other institutions. It is subversive of decent social and educational ideals for the president of Harvard University to be permitted to build on the grounds of the university a house for himself costing $100,000, and for the trustees of Columbia University to build for their president a house which with its grounds may cost twice that amount. But it would be in the interest of the university and of society if the salaries of professors were increased. Abuses are possible, but at present whatever makes the academic career more attractive to men of genius is in the interest of all the people.

The undeniable difficulties in the way of adjusting salaries and the conflicting needs of schools and departments, whether the decision rests primarily with the president, the trustees or a committee of the faculties, may be minimized by permanence of tenure and fixed salaries, and by giving the departments financial autonomy. President Van Hise, of the University of Wisconsin, and President Butler, of Columbia University, have recently pronounced in favor of the competitive system in the university. The former says: "There is no possible excuse for retaining in the staff of a university an inefficient man." The latter says: "A teacher who can not give to the institution which maintains him common loyalty and the kind of service which loyalty implies ought not to be retained through fear of clamor or criticism," and further in respect to equality of salaries: "In my judgment such a policy would fill the university with mediocrities and render it impossible to make that special provision for distinction and for genius which the trustees ought always to be able to make."

There are advantages in a system of severe competition for large prizes under honorable conditions, as well as in permanent tenure of office with small salaries and a free life; but confusion and harm result from running with the hare and hunting with the hounds. If there is to be competition in order to retain university chairs, then the university must be prepared to forego able men or to compete with other professions in the rewards it gives. It must offer prizes commensurate with those of engineering, medicine and law, namely, salaries as large as from ten to a hundred thousand dollars a year. It is further true that under these circumstances a man must be judged by his peers. A university which dismisses professors when the president thinks that they are inefficient or lacking in loyalty to him is parasitic on the great academic traditions of the past and of other nations. A single university which acts in this way will in the end obtain a faculty consisting of a few adventurers, a few sycophants and a crowd of mediocrities. If all universities adopt such a policy, while retaining their present meager salaries and systems of autocratic control, then able men will not embark on such ill-starred ships. They will carry forward scientific work in connection with industry and will attract as apprentices those competent to learn the ways of research.

Permanent tenure of office for the professor is not a unique state of privilege. A president's wife has permanent tenure of office; he can not dismiss her because he regards her as inefficient or because he prefers another woman. Analogous social conditions make it undesirable that he should have power to dismiss a professor for similar reasons. In the army and navy, in the highest courts, to a certain extent in the civil service of every country, there is permanence of office. Indeed it is nowhere completely disregarded; service is always a valid claim for continued employment. A wife may be divorced by the courts, an army officer may be court-martialed, a judge may be impeached; but such actions are taken only after definite charges and opportunity for defence. Permanent tenure of office is intended to improve the service, not to demoralize it. It is attached to honorable offices, where public spirit and self-sacrifice are demanded, and the wages do not measure the performance. In Germany, France and Great Britain the permanence of tenure has given dignity and honor to the university chair, attracting to it the ablest men and setting them free to do their work.

Incitement to the best work of which a man is capable is not excluded from the university if the professorship itself is made a high reward, the essentials of which are permanence, freedom and honor. Men who have proved their ability for research need opportunity rather than extraneous stimulus. Still it is true that while the lack of prizes does not considerably dampen the spirit of research, it makes the academic career less attractive to those who should be drawn to it. Most of the graduate students in our universities are men of mediocre ability, drifting along with the aid of fellowships and underpaid assistantships to an inglorious Ph.D. and a profession with meager rewards. Several of my correspondents write that if large income, power and honor were not attached to the presidency, there would be no prize to attract men to university work. From my point of view it is altogether demoralizing that the reward held before the investigator and teacher should be the position of an executive, politician and promoter, which takes him away from the higher work for which he is fit. It is a curious

exposure of the situation when the president of our largest university can write:

> Almost without exception the men who to-day occupy the most conspicuous positions in the United States have worked their way up, by their own ability, from very humble beginnings. The heads of the great universities were every one of them not long ago humble and poorly compensated teachers.[14]

It would be well if some universities would maintain professorships so highly rewarded and regarded that the possibility of a call would exercise a beneficial influence throughout the country, and if each university would establish from one to ten professorships having a salary and a prestige equal at least to that of the presidency. Vacancies in these professorships should be filled by cooptation or election by the faculties or by a faculty committee; but even under the present system of presidential nominations, it would be better to have a few important appointments made publicly than a number of small increases in salary made secretly as the result of presidential favor.

I venture to supplement my argument by quoting from an address[15] made ten years ago, which seems less radical now than then, since socialism has ceased to be a nightmare for respectable citizens, since pensions have become general, since Harvard has adopted the plan of equal salaries with increments of $500 after each five years of service, since Senator Villas has made provision at the University of Wisconsin for super-professorships, since the president of a university is no longer sacrosanct. The paragraph reads:

> The university is those who teach and those who learn and the work they do. The progress of the university depends on bringing to it the best men and leading them to do the best work. Our president, Mr. Remsen, in his admirable inaugural address, told us that the chief function of the university president is to find the right man, and his chief difficulty the lack of enough such men to go round. He considered the question of how far an increased salary would add to the supply of good men. I quite agree with Mr. Remsen that a professor will do about the same kind of work whether his salary is $4,000 or $10,000. If anywhere, in the university it should be to each according to his needs, from each according to his ability. The professor who must live in a city or who has children to educate should be given the necessary income. He should have an adequate pension in old age or in case of disablement; the university should insure his life in a sufficient sum to provide an income for his wife and minor children. The professorial chair can be made attractive by freedom, responsibility and dignity, rather than by a large salary. Still it must be remembered that we live in a commercial age, and men are esteemed in accordance with their incomes. While it may not, or at all events should not, matter greatly to the professor, it may be well for the community that those who do the most for it should be paid on the same scale as those of equal ability in other professions. It may not be necessary to double the salaries of all university men, but it would probably be desirable to have certain prizes that would represent to the crude imagination of the public the dignity of the office and would perhaps attract young men of ability. The average salaries of teachers are about the same as in the other professions, but there are no prizes corresponding to those in the other professions. A clergyman may become a bishop, a lawyer may become a judge, a physician may acquire a consulting practise; and they may earn incomes of from $10,000 to $100,000. A professor can only earn a large salary and an apparent promotion by becoming president of his university; and this I regard as unfortunate. As Mr. Remsen told us that the professor would be pleased, but not particularly improved, by an increase in salary, I may perhaps be permitted to suggest that a president might be pained, but would not be seriously injured, by a reduction of his salary to that of the professor. My preference in this matter would be for the professor to have a fixed salary—perhaps $3,000 to $6,000, according to the expense of living

[14] "The American as he is," by President Nicholas Murray Butler.

[15] Read before the members of Phi Beta Kappa of the Johns Hopkins University, on May 2, 1902, and printed in *The Popular Science Monthly* for June, 1902.

in the neighborhood, with $300 to $600 subsidy for each of his children between the ages of 10 and 21. Advances in salary dependent on the favor of the authorities appear to be undesirable. If salaries must vary from $3,000 to $5,000, a man should be appointed at such salary as may be necessary, but should thereafter receive automatic increases, say of $500 after each five years of service. Then there should be a few research chairs in each university, promotion to which would be a mark of distinction, and occupancy of which would dispense from all routine work and carry a salary equal to that of the presidency.

It is awkward to urge a reform, such as an increase in the salaries of professors or the advance of a few salaries to that of the presidency, when this would become superfluous or undesirable, if society as a whole could be reorganized on a just economic basis. Elsewhere[16] I have discussed the question as follows:

> The best reward for scholarly work is adequate recognition of the work as preparation for a career in life. At Columbia University a man takes his doctor's degree at the average age of 27 years. He is fortunate if he receives immediately an instructorship at $1,000 a year; the increments of salary are $100 a year for ten years, so that at the age of 37 he receives a salary of $2,000. In a commercial community the imagination is not stirred by such figures. The university is a parasite on the scholarly impulse instead of a stimulus to it.
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> The first need of our universities and colleges is great men for teachers. In order that the best men may be drawn to the academic career, it must be attractive and honorable. The professorship was inherited by us as a high office which is now being lowered. Professors and scholars are not sufficiently free or sufficiently well paid, so there is a lack of men who deserve to be highly rewarded, and we are in danger of sliding down the lines of a vicious spiral, until we reach the stage where the professor and his scholarship are not respected because they are not respectable.
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> I should myself prefer to see the salaries, earnings and conveyings of others cut down rather than to have the salaries of professors greatly increased. When a criminal lawyer—to use the more inclusive term for corporation lawyer—receives a single fee of $800,000, our civilization is obviously complicated. Every professor who is as able as this lawyer and who does work more important for society can not be paid a million dollars a year. But neither is it necessary to pay him so little that he can not do his work or educate his children. I recently excused myself somewhat awkwardly for not greeting promptly the wife of a colleague by saying that men could not be expected to recognize women because they changed their frocks. She replied: "The wives of professors don't." It is better to have wit than frocks; but in the long run they are likely to be found together.
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> The first step of a really great university president would be to refuse to accept a larger salary than is paid to the professors. The second step would be to make himself responsible to the faculty instead of holding each professor responsible to him. The bureaucratic or department-store system of university control is the disease which is now serious and may become fatal. This subjection of the individual to the machinery of administration and to the rack wage is but an invasion of the university by methods in business and in politics from which the whole country suffers. We may hope that it is only a temporary incident in the growth of material complexity beyond the powers of moral and intellectual control, and that man may soon regain his seat in the saddle.

I myself accept the social ideal: From each according to his ability, to each according to his needs; and I believe that, thanks to the applications of science, the resources of society are sufficient to provide adequately for all. But the first step to take in our present competitive system is to make rewards commensurate with effective ability and a compromise between services and needs. I have pointed out that, apart from exceptional cases, the range of individual differences in many traits is about as two to one. Thus in accuracy of perception and movement, in quickness of recognition and reaction, in rate of learning and retentiveness of memory, in time and variety of the association of ideas, in validity of judgments, I have

[16] "The Case of Harvard College," an address before the Harvard Teachers' Association, *The Popular Science Monthly*, June, 1910.

found in laboratory experiments a range of difference of this magnitude. The able student can prepare a lesson or earn the doctor's degree in about half the time required by the poorer student. For the same kind of work and under similar conditions the value of the services of an individual varies within somewhat the same limits. A good laboring man or a good clerk is worth as much as two who are mediocre. The value of genius to the world is of course inestimable. A great man of science may contribute more than even the most successful promoter—a Rockefeller, a Carnegie or a Morgan—gets. But such contributions are made possible by the organization of society as a whole, and should in large measure be distributed among its members, preferably in the direction of making further contributions possible. Scientific men should receive adequate rewards, and the surplus wealth which directly or indirectly they have produced—it must be counted by the hundreds of thousands of millions of dollars—should, in so far as this can be done to advantage, be spent on further scientific research.

The available wealth in the United States and Great Britain suffices to provide a home and the tools of production for each family and the productivity of labor to provide an annual income of about $1,000 for each producer. If waste in production and expenditure were reduced, even to the extent that now obtains among teachers and scientific men as a group, there would probably be available $1,500 for each adult, including women engaged in the care of the home, or $3,000 for each family. If this were distributed on a range of two to one in accordance with ability, the more deserving teachers and scientific men with their wives would earn salaries of $4,000, in addition to owning their homes. An addition of from $250 to $1,000 should be allowed for each child requiring support and education, to be deducted in part from the incomes of those having no children, and allowance should be made for the varying cost of living in the city or the country and the like.

If the maximum income of a university professor or scientific man with a family should be from $5,000 to $10,000, no one should receive more, except to cover greater risks. There is no occupation requiring rarer ability or more prolonged preliminary training, and there is none whose services to society are greater. If there are to be money prizes—incomes of $20,000 or $100,000 or more—then they should be open to professors and investigators. Scientific ability is as rare as executive or legal ability, and is far more valuable to society. The lawyer who receives a fee of $800,000 for enabling a group of promoters to get ten times as much by evading the intent of the law, does not add to the wealth of society. The scientific man who increases the yield of the cereal crop by one per cent. adds $10,000,000 a year to the wealth of the country and five times as much to the wealth of the world. The scientific man who discovered and those who have developed the Bessemer process of making steel have, according to the estimate of Abram S. Hewitt, added $2,000,000,000 yearly to the world's wealth. There is no reason except the imperfect adjustments of society why the lawyer should receive large rewards and the scientific man a scant salary. Those who render services to an individual or group are likely to be paid in accordance with the value of their services to the individual or group; in our competitive system those who render services to society as a whole are not paid at all, or only partially and indirectly. Of our thousand leading men of science, 738 are employed in uni-

versities and colleges, 106 in the government service, 59 in research foundations. It is the duty of these institutions to provide adequately and liberally for their support and for their work.

The rewards of the academic and scientific career deserve detailed discussion because they are of fundamental importance to the university and to society. Professors and investigators should have adequate incomes, as large as is desirable for any social class, but above all they should have opportunity to lead a life free from distracting or dishonorable compromises. It should be emphasized that nothing here written is intended to promote a privileged class of university professors. Valparaiso University and Mr. Edison's Menlo Park Laboratory are useful, as well as Harvard University and the Rockefeller Institute for Medical Research. My concern is only that the university should be of the greatest possible service to the people and to the world. It may be that the great bulk of routine teaching and routine research can be done most economically under the factory system, with a manager to employ and discharge the instructional force and bosses to keep each gang up to a square day's work. But then the highest productive scholarship and creative research must find refuge elsewhere than in such a university.

It is truly distressing that our universities should be so conventional and unimaginative, each trying to follow the lead of those bigger than itself, all lacking in fineness and distinction. The Johns Hopkins, Clark, Stanford and Chicago were founded one after the other with promise of higher things, and each has relapsed into the common mediocrity. Harvard and Yale maintain the traditions of scholarship; the Johns Hopkins and Chicago have not abandoned the ideals of research; Columbia looms up with the vastness and crudeness of the metropolis; the state universities exhibit the promise and the immaturity of our democracy. But each and all unite the scholasticism of the twelfth century with the commercial rawness of the twentieth century. Can there not be one university where the professor will have a study instead of an office, where the ideal set before the young instructor is something else than answering letters promptly and neatly on the typewriter, where men are weighed rather than counted, where efficiency and machinery are subordinated to the personality of great men? Could there not be a university or school, dominating some field of scholarship and research with its half-dozen professors and group of instructors and students drawn together by them? Might not means be devised by which the professor would be paid for the value of his teaching, service and research, and then be set free to do his work how and when and where he can do it best? It is not inconceivable that there should be a national or state university, with some features of the royal academies, rewarding with fellowships men of unusual promise and with professorships men of unusual performance, endowing the individual instead of the institution.

If it is not possible at present to have free professors and independent schools, we can at least strive for greater freedom of the individual and larger autonomy of the department within the university. As the position and salary of the professor should not depend on the favor of a president, so the department or school should be allowed substantial autonomy. There is nothing more disheartening to the members of a department or school than to have its activities prescribed or limited, its annual appropriation apportioned, by a centralized system. A great danger confronting the modern university is its own

bulk. In the evolution of organic life a limit is placed on the size which an animal can attain. Its surface increases more slowly than its mass, and there must be differentiation and division of labor in order that the animal may grow and react properly to the environment. Even then a limit is fixed; it is doubtful whether apart from the nervous system a structure more complicated than that of the mammal will be reached, or that animals much larger than man will survive. Only a polyp or similar creature can conduct a pure democracy; the organization of higher animals must be more complicated. The growth in size of the American university has been large and rapid. Faculty or town-meeting methods have become difficult or impossible; the institution drifts into autocratic and bureaucratic control. A representative or delegated system of government is necessary for the university, as a whole, but its divisions can maintain a family and democratic system.

President Eliot says[17] that a long tenure of office will be an advantage to the president and to the university he serves, but that the chairman of departments should be chosen for short periods and should generally be junior or assistant professors to give them opportunity and because "dangers from the domination of masterful personages will be reduced to a minimum under this system." It is not evident why it is less desirable to limit "the domination of masterful personages" in the office of the president or of the dean than in the department. But it is true that a departmental autocracy may be even worse than one on a larger scale, and for the reason that it is conducted in the dark. A president may say that a teacher "ought not to be retained through fear of clamor or criticism," but fortunately public opinion does prevent the more serious abuses to which the system is liable. In certain departments of certain universities instructors and junior professors are placed in a situation to which no decent domestic servant would submit. Clearly that is no breeding ground for genius and great personalities.

It can not be denied that the organization of the departments of a university is one of the difficult problems that confront us. The German plan, according to which the individual rather than the department is the unit, is in many ways preferable. But the American university conducts what is practically a secondary school in the first two years of the college, and it conducts professional schools which are not of university grade. The high schools and small colleges should take over the first two years of the college, establish schools of agriculture and of the mechanic arts, and conduct courses preparatory to medicine, law, engineering and teaching. In a large state, the state university would have one hundred thousand students, if it received all the young men and women between the ages of sixteen and twenty who should continue educational work. Such education should be provided locally and in connection with productive industry, as in the admirable plan adopted by the school of engineering of the University of Cincinnati, by which students work alternate weeks in the university and in the shop. Under President Eliot, Harvard placed both its college and its professional schools on a university basis; under President Lowell, it has moved backward in the direction of making the college a school of information and culture and of requiring the professional school to begin with the elements. To such an extent is the university the plaything of its president!

[17] "University Administration."

For administrative and financial purposes it seems necessary to organize the university into schools, divisions or departments, although for educational purposes as much flexibility as possible should be maintained. The scope and size of such a division should depend on convenience and local conditions, rather than on logical distinctions among the subjects taught. A small college or a small medical school can be conducted to advantage under one faculty. In a large university there is no need to have a separate department for each of the oriental languages because they differ from one another more than do the European languages, though it may be desirable to have separate departments for German and French. When a medical school, or even the work in a special science, such as chemistry, becomes large, it may be advisable to organize it into partly autonomous divisions. There is no gain in economy and usually a loss in cooperation and effectiveness when the entering class of a college or professional school exceeds fifty or a hundred, and when its faculty exceeds twenty or thereabouts. Colleges should remain small; if a university must have a great crowd of college students, they should be divided among separate colleges, as in the English universities. These colleges should not, however, consist of freshmen, as President Lowell plans, or of students belonging to a certain social class, as is likely to happen under the fraternity and club system, but of men having common intellectual interests. Even small colleges for general education should aim to excel and to do research work in some special direction. In the large university the residential colleges and departments should coincide, so that younger men will join a group of older students and instructors having similar interests and ends in life. As I have elsewhere remarked:

> The ideal is the zoological hall of the old Harvard, where apprentices of a great man and a great teacher lived together. This is told of again in the charming autobiography of Shaler. A boy from the aristocratic southern classes, with ample means and good abilities but no fixed interests, fell into this group. There he discovered his life work and pursued it with boundless enthusiasm. Nor did the fact that he devoted himself exclusively to professional work in natural history in college prevent him from writing Elizabethan plays in his old age. The number of men of distinction given to the world from this small Agassiz group is truly remarkable.

A group of some 10 to 20 instructors, having registered primarily under them from 50 to 200 students, is a good size for a school, division or department. Each can be well acquainted with the others and take a personal and intelligent interest in all the work of the department. At the same time the number is sufficient to permit the representation of diverse kinds of work and points of view, and to make possible the election of officers and a democratic control. The chairman or head and an executive committee should of course be elected, not named by a semi-absentee president. In a group of this character questions are not usually brought to a vote. In reaching decisions each member is likely to be weighed as well as counted. In my experience the junior members of a faculty or department take too little rather than too much share in its discussions and its control. If they obtained constitutional rights they might become more aggressive; if they should, so much the better. One of the serious difficulties of the present system is that the younger men do not share in the conduct of the university and do not feel themselves to be part of its life. Those who do not have their ideas before they are thirty are not likely to have them. The paraphernalia and camp baggage of modern civilization have become so heavy that they threaten to block its further advance. If men must devote thirty years to mere

acquisition, and be kept even longer in official subjection, there is not much chance that they will do anything else thereafter. What youth can do should be joined with what age can know.

Voting rights in a department might be in proportion to the salary the officers receive; but such statutory regulations are scarcely needed. The real control is vested in the aggregate common sense of those concerned. The group may well be flexible in character. When courses of instruction and educational problems are under discussion assistants and even graduate students may be admitted to advantage. When the question is the promotion of an instructor, the group would naturally be limited to those of higher office. The chairmanship of the department might rotate among its members or the same head might be reelected continuously according to convenience. It by no means follows that the professor most eminent in research should be the executive head; on the contrary, it should usually be a man of competent administrative ability whose time is of less value. Every reasonable man believes in economy in administration and letting the men do things who can do them. Even the most important decisions can be left to the head of the department or its executive committee, so long as they represent and are responsible to the whole department.

The school or department should have complete control of its own educational work. So long as there is ample room for differences of opinion as to the value of different subjects and methods, it is well that there be variation and survival of the fit. Entrance requirements and degrees are among the chief obstacles to education. An instructor in Columbia University said recently to a student who had just received the highest grade assigned in the course: "Why did you take the course, if you don't want a degree?" If there must be degrees, it may be necessary to standardize them; but this should be done only to the extent of prescribing the amount of work to be done in the direction called for by the degree, this being determined by the time spent, weighted in accordance with the ability of the student. I shall print shortly statistics in regard to all doctorates of philosophy granted in the sciences by American universities. For each department of each university will be given the percentage of doctors who continued to pursue scientific work and the percentage who attained a given degree of distinction. If any police regulation is needed, such publicity is far better than the examination of a candidate before the faculty, or the requirement of all sorts of qualifications.[18]

Financial as well as educational autonomy should be given to the school or de-

[18] This paper is concerned with problems of administration, not with questions of teaching and research. The latter are by far the more important; indeed administrative methods are only of consequence in so far as they affect education within and without the university, research and the applications of knowledge. Incidentally I may remark that I should give the student the same freedom and the same democratic system that I should like to see the teacher enjoy. I should admit to the university any student and let him stay there so long as his presence did not do injury to others. I should let him choose his own work and his own methods of work, not because all kinds and methods of work are equally good, but because I regard myself as incompetent and most of my colleagues as even more incompetent to impose any system on the student. I should in large measure do away with grades, required attendance, required courses, required examinations and degrees, not because these things are not in some ways and in some cases useful, but because on the whole they do more damage than good. So far as possible, I should let students manage their own affairs, their dormitories, fraternities and athletics, their codes of manners and of morals.

partment. Its total income should be held as a trust fund, to be decreased only after full and public investigation. The laboratories, rooms, apparatus, equipment, library, etc., should be held in trust for the department, to be taken away against its will only for clear reasons and on the recommendation of a competent faculty committee. Under these conditions the members of a department will plan on a safe basis for the future, and will seek to increase its funds and facilities. I know of a case in which a professor obtained a gift of $100,000, made expressly "to increase the facilities of the department," and the income was assigned by the president and trustees to pay the salary of that professor against his earnest protest. I also know of a case in which a department which had built up one of the strongest laboratories in the country had those of its rooms especially devoted to research taken away and given to a weak department, to induce a certain professor to accept a call from elsewhere to the headship of the weak department. These are of course extreme cases and might seem incredible, if it were not that interference with the vested rights of departments is of frequent occurrence.

The Harvard plan of visiting committees which may take an active interest in the educational work and financial support of departments is commendable. Under the existing trustee system it might be well if one trustee would concern himself especially with one or two departments, attending their meetings and doing what he could to advance their interests. There can to advantage be within the university departments related to its educational work, but under independent control. Thus the most useful and vigorous division of Columbia University, with the possible exception of the faculty of political science, is the Teachers College, which is under its own trustees with a dean and faculty responsible to them. As a department of education under the trustees of Columbia College, it would probably have had no more leadership than the departments at Harvard or Yale. The educational alliance between Columbia University and the Union Theological Seminary is far better than a school of theology under the trustees of the university. There is no valid objection to two schools of law or two schools of chemistry, independently controlled, but enjoying the advantages of educational affiliation with a university. Endowed research institutions and municipal, state or governmental bureaus, can to advantage be placed near a university, contributing to and gaining from its educational work.

Appointments and the apportionment of funds are said to be questions insoluble under democratic control. But in spite of the difficulties the case is not so bad as autocratic one-man power. If there are fixed salaries with automatic increases, only three or four decisions must be made. Shall this man be appointed instructor? Shall he be appointed junior professor after five or ten years of service as instructor? Shall he be appointed full professor after five or ten years of service as junior professor? Who shall be appointed to super-professorships, if such exist? As a matter of fact under the existing system instructors and junior professors are nearly always nominated by the department or its head. They alone have the necessary information in regard to the men and the situation. The nomination of a full professor can be entrusted better to the department concerned than to a president. But such an appointment being for life and of immense consequence can not be too carefully guarded. It should be passed on by

a board or committee composed, say, of two members of the department, two members of allied departments and two distinguished representatives of the subject outside the university concerned. Such control would prevent undesirable inbreeding or the further deterioration of a weak department. Nominations should be made publicly—the English plan of definite candidates with printed records has much to commend it—and the power of veto should perhaps be given to the faculties as well as to the trustees.

The apportionment of the existing income of a department varies but little from year to year, and can safely be left to the department. Questions arise only when an increase which the department can not itself obtain is wanted, and there are general funds available, but not sufficient to supply all the needs of the university. Under the existing system each head of department grabs for everything in sight, and the president plays the part of an inscrutable and sometimes unscrupulous providence in the semi-secret distribution of his favors. No scheme could be more demoralizing. The correct plan is for each department to draw up its budget, with requests for increases and the reasons clearly indicated, the proposed budgets being printed and open to all concerned. Under these conditions unreasonable claims would not often be made by the departments. Plans for new departments and new lines of work could also be submitted by any responsible group. An elected committee of professors, with the assistance of an expert curator or controller, would then pass on the various budgets and proposals and adjust them to the available income, the reductions made by the committee being of course published. The budget for the university would then go to the trustees. It may be objected that under this plan existing work would be strengthened rather than new ground broken. But might not this be better than the existing presidential mania for expansion? It seems in fact probable that if many professors and junior instructors were concerned, there would be more new ideas than when the initiative is left to a single man, and further that wise plans would be more likely to be adopted and inexpedient schemes to be rejected.

When schools and departments have autonomy, there is no need for much super-legislation and super-administration in the university. The machinery should be as simple as may be. Departments may be united into a school or college and elect a dean and a faculty or an executive committee to coordinate the work. A department can elect members to represent it in allied departments and on the faculties of the schools and colleges with whose work it is concerned. There should be an elected council or senate to represent the entire university and an executive committee which can confer with the executive committee of the trustees. There may at times to advantage be faculty meetings or plebiscites of large groups or of all the officers of the university. Questions concerning the entire university can be discussed to advantage by the fly-leaf method of the English universities, and a vote can be taken without a general assembly at a polling booth or by mail.

There are advantages and disadvantages in large faculty meetings. When all important matters are decided by administrative officers or executive committees and only trivial questions are discussed before the faculty, usually by certain polyphasiac members, its meetings are likely to fall into disrepute. Men are efficient in direct proportion to their responsibility. Further, a body of men is effective inversely as its

size and directly as the time it works together. A body of fifty men such as the faculty to which I primarily belong, meeting for an hour three times a year, without power or responsibility, is clearly dedicated to futility. But if any one supposes that university presidents would do better under these conditions, he should call to mind the conduct of the trustees of the Carnegie Foundation. It seems to be the case that in order to make large faculties real legislative bodies, it would be necessary to devote more time to their meetings than is expedient, and perhaps more common sense than is available. All parliaments, congresses and legislatures do their work through cabinets and committees; but these are responsible to the whole body. Some such plan is necessary in the university. Still the cynical attitude toward faculty meetings common in academic circles appears to be one of the sinister symptoms resulting from the existing methods of autocratic control. It is typical of existing conditions that the most recent university school to be established—the School of Journalism of Columbia University—does not have a faculty but an "administrative board." I belong to a club at the meetings of which each member must speak once and only once, not exceeding his share of the time, and the discussion is followed by a dinner. If faculty meetings could be made into educational and social clubs they would perform a useful function. The meetings of the faculty of arts and sciences at Harvard may give rise to complaints, but they have been of real service to the university.

Truth, openness, publicity, are the safeguards of free institutions. It is better to wash your dirty linen in public than to continue to wear it. The affairs of a university should be conducted in the full light of day. The proceedings of the trustees, the discussions and conclusions of faculties and of committees, the activities of the president, the work of professors, salaries and the provisions of the budget, the appointment of officers and the rare cases in which it is necessary to dismiss a professor, should be open to all. Light is an excellent disinfectant; what is of more consequence, it is essential to healthy life and growth. "And God said, let there be light: and there was light. And God saw the light, that it was good."

Several of my correspondents argue that if the control of a university were vested in its teachers, they would be distracted from their proper work of teaching and research. In a recent article[19] on "The University President in the American Commonwealth," President Eliot writes:

> Most American professors of good quality would regard the imposition of duties concerning the selection of professors and other teachers, the election of the president, and the annual arrangement of the budget of the institution as a serious reduction in the attractiveness of the scholar's life and the professorial career.

Do President Eliot and the lesser presidents and the few professors who share their views believe that university professors and other citizens of a city should not concern themselves with municipal government or vote for a president of the nation? Are we of the world's greatest democracy and in the twentieth century to revert to the theory that the common people should do the daily work imposed on them, and trust to the king and his lords to care for them?

In the preface to the first edition (1906) of the "Biographical Directory of American Men of Science," I wrote:

> There scarcely exists among scientific men the recognition of common interest and the spirit of cooperation which would help to give science the place it should have in the community. It is fully

[19] *The Educational Review*, November, 1911.

as important for the nation as for men of science that scientific work should be adequately recognized and supported. We are consequently in the fortunate position of knowing that whatever we do to promote our own interests is at the same time a service to the community and to the world.

Trade unions and organizations of professional men, in spite of occasional abuses, have been of benefit not only to those immediately concerned, but to society as a whole. President Eliot did not obtain commendation for calling the "scab" a hero. But if it is expedient to better the conditions under which work of any kind is done, this is of the utmost importance for education and research. If we can unite to improve the conditions of the academic career, so that it will attract the best men and permit them to do their best work, we make a contribution to the welfare of society which is permanent and universal. It may be that the time has now come when it is desirable and possible to form an association of professors of American universities, based on associations in the different universities, the objects of which would be to promote the interests of the universities and to advance higher education and research, with special reference to problems of administration and to the status of the professors and other officers of the university.

The space at my disposal is exhausted and many problems directly and indirectly concerned with the control of a university remain untouched. I am well aware that this paper is written in the spirit of the advocate and the reformer, rather than from the point of view of the judge and the responsible administrator. Against most of the suggestions which have been made valid objections may be urged. The only principle that I am prepared to defend whole-heartedly is that the university should be a democracy of scholars serving the larger democracy of which it is a part. A government of laws is better than a government by men; but better than either is freedom controlled by public opinion and common sense, by precedent and good will. As that nation is happy which has no history, so that university is fortunate which has the least administration, and my most inclusive answer to the question how to administer a university is—don't.

J. McKeen Cattell

## *SCIENTIFIC NOTES AND NEWS*

The cost of preparing for publication the unfinished manuscripts left by the late Professor C. O. Whitman, together with that of the publication of the same in the best possible manner when ready, has been undertaken by the Carnegie Institution of Washington. Provision is also made for the maintenance of the large collection of pigeons, and for the current researches with them. Dr. Oscar Riddle, in charge of the work, has been appointed a research associate in the Carnegie Institution.

The University of California has conferred the doctorate of laws on Dr. George E. Hale, director of the Solar Observatory of the Carnegie Institution, and on two of its graduates, Dr. Sidney E. Mezes, professor of philosophy and president of the University of Texas, and Dr. E. C. Sanford, professor of psychology and president of Clark College.

Cambridge University will give the honorary doctorate of science to Major Leonard Darwin, lately president of the Royal Geographical Society.

The University of Manchester will confer the degree of doctor of science on Dr. B. H. Scott, F.R.S., the distinguished botanist.

Professor Nocht, director of the Tropical Institute at Hamburg, succeeds Professor Baelz as president of the German Tropical Society.

King Alfonso has given an audience at Madrid to Mr. Marconi, and has conferred on him the Grand Cross of the Order of Alfonso XII.

THE members of the Bureau of Chemistry have presented to Dr. H. W. Wiley, as a farewell gift, a chest containing 144 pieces of flat silver, a massive meat platter with side dishes, and a porringer, pap spoon and cup for Harvey W. Wiley, Jr., born on May 16. The plate on the mahogany chest is inscribed as follows: "To Harvey W. Wiley, whose leadership has been an inspiration to all who have had the privilege of knowing personally, day by day, the breadth and depth of his well-stored mind, his unshakable integrity and his splendid poise and never-failing geniality under any and all conditions. From the Bureau of Chemistry, U. S. Department of Agriculture, 1883–1912."

AN expedition for the further collections of fossil American horses for the Peabody Museum, Yale University, will be conducted this summer under the direction of Professor Richard S. Lull, associate curator in vertebrate paleontology. The party will explore in the Panhandle region of Texas and the banks of the Niobrara River in central Nebraska. Mr. Frederick Darby, one of the preparators in the Peabody Museum, and possibly one or two volunteers will accompany the expedition.

MR. A. E. PRATT, accompanied by his son, Mr. Felix B. Pratt, arrived in Piura, Peru, on May 3, direct from London *via* Barbados and Panama. They outfitted in Piura for the trip overland to Iquitos on the Upper Amazon. The object of the expedition is the collection of natural history specimens, chiefly butterflies, beetles and birds. The first sets go to a private collection and the rest to the British Museum of Natural History. Mr. Pratt and his son have spent three years in similar work in the interior of New Guinea, and have also worked in Australia, Madagascar and South America. They carry a full outfit and will proceed by way of Huancabama, Jaen and the Marañon. From Iquitos they will follow the Amazons down to Pará, and thence back to England.

THE *Journal* of the American Medical Association states that the scientific investigations at Teneriffe have received a new extension by the erection of a station for observing anthropoid apes. Professor Rothmann, of Berlin, and Frau Professor Selenka, of Munich, have been sent to Teneriffe by the department of education to make preparations to this end, since it may be expected that in the uniformly warm climate there the animals may be kept in the open air through the entire year under the conditions of life that are natural to them.

MR. ARTHUR MAURICE HOCART has been elected to a senior scholarship at Exeter College, Oxford, for two years for the purpose of carrying out anthropological research in Fiji.

PROFESSOR JOSEPHINE E. TILDEN, of the University of Minnesota, has been given leave of absence on half salary, for the coming year, to carry on botanical research in the Islands of Tahiti and New Zealand.

PROFESSOR ARTHUR GORDON WEBSTER, of Clark University, sailed on the *Mauretania* on May 22 to take part as a delegate of the United States government in the Radio-Telegraphic Conference held in London in June, to represent Clark University at the quarter-millennial celebration of the Royal Society in July and to attend the International Congress of Mathematics at Cambridge in August. Professor Webster is one of the six Americans whose names appear on the international committee of the congress.

DR. WILLIAM H. F. ADDISON, of the medical department of the University of Pennsylvania, has sailed for Germany, to study with Professor Edinger at Frankfurt-am-Main.

T. POOLE MAYNARD, Ph.D. (Hopkins), has resigned as assistant state geologist, Geological Survey of Georgia, and will open an office as a consulting and mining geologist.

H. R. FULTON, associate professor of botany in the Pennsylvania State College and botanist in the station, has been appointed botanist and vegetable pathologist in the North Carolina College and Station.

DR. BERNHARD FITTIGE, associate professor of chemistry at Marburg, died on April 27, aged sixty-two years.

Professor F. O. Grover, head of the department of botany in Oberlin College, has been appointed by the faculty to represent the college in the Ohio Biological Survey.

Professor G. C. Comstock delivered the annual Sigma Xi address at the University of Michigan on May 24, speaking on "The Visible Universe as a Subject of Current Speculation."

Professor Eliot Blackwelder, of the University of Wisconsin, delivered an illustrated lecture on "The Physical Geography of China and its Influence upon the People," on May 3 under the auspices of the College of Science Student's Union of the University of Illinois. The union was organized this year with representatives from the various scientific societies, and it has been so successful that the engineering societies are planning a similar union. Professor H. C. Taylor, head of the department of agricultural economics at the University of Wisconsin, gave three lectures at the University of Illinois on May 16 and 17 on the following topics: "The Economic Conditions which Determine Types of Dairy Farming," "The Economic Aspects of the Farm Problem," and "The Value of Cost Accounting on the Farm." Dr. A. L. Winton, of the Chicago Laboratory of the U. S. Bureau of Chemistry, lectured last week at the university on "Microscopic Food and Agricultural Analysis," under the auspices of Phi Lambda Upsilon, the honorary chemical fraternity.

The one hundred and thirtieth Harveian festival will be held in the hall of the Royal College of Physicians, London, on May 31, when the president, Dr. Charles Watson MacGillivray, will give the Harveian Oration on "Some Memories of Old Harveians, with Notes on their Orations."

Under the auspices of the Geographical Society of Philadelphia, a botanic and geographic expedition is to be made this summer to southern Florida by Professor John W. Harshberger, of the University of Pennsylvania. Professor Harshberger has made two previous trips to Florida and this expedition is to complete his studies in the Everglades region of the extreme southern part of the peninsula. The itinerary will be approximately as follows: Making Fort Meyers on the west coast headquarters, Professor Harshberger will first investigate the region in that vicinity; visits will be made to several of the islands along the gulf coast; the Caloosahatche will be ascended by power boat to Lake Okeechobee and the flora of that inland lake will be studied. Then the attempt will be made (if the drainage canal has been sufficiently constructed) to cross the Everglades to Fort Lauderdale on the east coast. As no botanical geographer has ever crossed the Everglades, unusual opportunities will be presented to study a region of great scientific interest. Photographs will be taken of the vegetation, the region will be mapped botanically, and a collection of the more interesting plants will be made. An abstract of the results of this expedition will be published in the October number of the *Bulletin* of the Geographical Society of Philadelphia.

Through the liberality of a friend, the Smithsonian Institution will be enabled to participate in a zoological expedition to the Altai Mountain region of the Siberian-Mongolian border, central Asia, an exceedingly interesting territory, from which the National Museum at present has no collections. Mr. Ned Hollister, assistant curator, division of mammals, U. S. National Museum, will represent the institution and make a general collection of the birds and mammals. He will have as a field assistant Mr. Conrad Kain, of Vienna, Austria, an Alpine guide. The party leaves New York on May 22 for London, whence the field will be reached by way of St. Petersburg and the Siberian Railway. The scene of the survey and exploration, the Altai Mountain region, is a particularly wild country. These mountains are inhabited by the largest of the wild sheep, which, with the ibex, will form the principal big game animals sought by the party, but a complete and general collection of smaller mammals and birds will also be made. At present it is the expectation of the party to remain in the field for four months, returning to the United States about the first of October.

## UNIVERSITY AND EDUCATIONAL NEWS

MR. CLARENCE H. MACKAY and his mother, Mrs. John W. Mackay, have given $150,000 to the University of Nevada, making their total gifts $400,000.

ALLEGHENY COLLEGE has completed the raising of $400,000 thereby securing the $100,000 conditional gift of the General Education Board. This makes the total productive endowment of the college $1,025,000. At the same time $20,000 has been given for a new athletic field, $20,000 to pay a deficit in running expenses and $60,000 as an endowment fund which is not immediately productive. President Crawford stated in his announcement on the completion of the fund, that the immediate results would be the addition of two new assistant professors and several new instructors to the faculty and the giving of an additional income to the library.

THE corner-stone of the new $125,000 School of Commerce building of the University of Illinois, was laid on Tuesday, May 21. A special university convocation was held in the auditorium at 4 P.M. Addresses were given by Governor Charles S. Deneen, of Illinois; President E. J. James, of the University; Dean David Kinley, director of the Course of Commerce; President W. L. Abbott, of the board of trustees, and others. In addition to the usual subjects taught, such as insurance, public finance, business organization and economics, etc., the school will give courses in shop and factory organization and management.

DR. C. A. DUNIWAY, whose term of office as president in the University of Montana, was, as readers of SCIENCE will remember, terminated by the regents, has been elected president of the University of Wyoming. The University of Wyoming has about twice the income of the University of Montana.

DR. ALEXANDER MEIKLEJOHN, professor of philosophy and dean of the faculty of Brown University, has been elected president of Amherst College.

PROFESSOR B. M. DUGGAR, of Cornell University, has been elected to fill the professorship of plant physiology and applied botany in Washington University, vacated by Dr. George T. Moore in accepting the directorship of the Missouri Botanical Garden.

MR. REYNOLD K. YOUNG (A.B., Toronto, '09), for the past three years fellow in Lick Observatory, has been appointed instructor in astronomy and physics in the University of Kansas. Mr. Young takes his doctor's degree from the University of California in June.

MR. ANSEL F. HEMENWAY, of the University of Chicago, has been appointed professor of biology and geology in Transylvania University, Lexington, Ky., to succeed Professor Charles A. Shull who has recently resigned.

PROFESSOR J. K. H. INGLIS, of University College, Reading, has been elected professor of chemistry at Dunedin University College, New Zealand.

DR. RICHARD GANS, docent for physics at Strasburg, has been elected professor of experimental physics at the University of La Plata.

MR. JAMES HENDRICK, lecturer in chemistry at Aberdeen Agricultural College, has been appointed professor of agriculture in the university.

DR. HERMANN BRAUS has been promoted to be full professor and director of the anatomical laboratory at Heidelberg.

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## DISCUSSION AND CORRESPONDENCE

### THE WHITE-TAILED DEER OF MICHIGAN

Two white-tailed deer, *Odocoileus virginianus* Bodd. and *O. v. borealis* Miller, are said to occur in Michigan. The northern form (variety *borealis*) is still abundant in the northern peninsula, and numerous specimens from that region are in the University of Michigan Museum of Natural History. But unfortunately in the southern peninsula the deer have become nearly exterminated, and as apparently but very few specimens or sufficiently careful descriptions of specimens

have been preserved, and this is the part of the state in which one would look for the typical form, the problem of determining the species that formerly inhabited this region is not an easy one to solve.

The northern limit of the range of the typical form has only been vaguely given by the different authorities. Thus Hahn[1] says "from the region of the Great Lakes," Rhoads[2] states that it occurs "from southern New York and Michigan," and Seton[3] gives it approximately the two southern tiers of Michigan counties in his map of the range of the species. Apparently none of these statements are based upon definite information, as we have been unable to find any specimens or information that would lead us to believe that the typical form ever occurred in Michigan even in the southernmost counties.

There are two skulls from Wexford county in the museum that are evidently to be referred to variety *borealis*, the lower row of cheek teeth measuring 83 mm.[4] in one and 79 mm. in the other, which has not yet acquired the rear lobe of the third molar. This confirms the opinion held by most writers that the northern form is found in the northern part of the lower peninsula. There are also in the collection, however, a skull from Livingston County (No. 5240) and sub-fossil jaws from Washtenaw County (No. 42,532) and Branch County (No. 42,531) in which the lower row of cheek teeth measures 83 mm., 82 mm. and 90 mm., respectively. These specimens with the statements of former residents[5] of Washtenaw and Wayne counties that the deer of these counties had a gray coat in winter seems to constitute pretty clear evidence that the variety *borealis* formerly ranged clear to the southern boundary of the state to the exclusion of the typical form.

Alexander G. Ruthven,
Norman A. Wood
University of Michigan
Museum of Natural History

[1] Hahn, W. L., "The Mammals of Indiana," 33d Ann. Rept. Indiana Dept. of Geology and Natural Resources, 1908, p. 458.

[2] Rhoads, S. N., "The Mammals of Pennsylvania and New Jersey," 1903, p. 24.

[3] Seton, Ernest Thompson, "Life-Histories of Northern Animals," 1909, p. 75.

[4] The length measured along the grinding surface of the teeth.

[5] See "Michigan Pioneer and Historical Collections," Vol. IV., p. 486 *et seq.*, and p. 542.

### THE FLORA BRASILIENSIS

To the Editor of Science: Referring to the note regarding the set of the "Flora Brasiliensis" recently acquired by the University of Illinois and the statement that it is the fourth obtained by American libraries, the others being at Harvard, Columbia and the Shaw Botanical Gardens,[1] it may be worth while to state that there is a complete set in the library of the Academy of Natural Sciences of Philadelphia, the volumes issued prior to the abdication of Dom Pedro II. having been received as a gift from him in evidence of his appreciation of the attentions shown him by the academy in 1876, during his attendance on the Centennial Exposition.

A detailed account of the emperor's visit will be found in my "History of the Academy."

Edw. J. Nolan,
*Secretary and Librarian*

To the Editor of Science: In your department of "Scientific Notes and News" of April 26, 1912, there is a statement that the set of "Flora Brasiliensis," which has just been added to the natural history library of the University of Illinois makes the fourth set obtained by American libraries, "others being at Harvard, Columbia and the Shaw Botanical Gardens." Will you kindly mention the fact in Science that the library of the Ohio State University has a complete set of "Flora Brasiliensis"? In the very early days of the university the first parts of the "Flora" were presented to the university by Mr. William S. Sullivant, of Columbus, with the understanding that the university would keep up the subscriptions. This was done and the parts as issued were received regularly by the university library. On the completion of the

[1] Science, XXXV., No. 904.

work it was bound in volumes, making a very handsome as well as valuable set.

OLIVE JONES,
*Librarian*

AN EXPERIMENT ON A FASTING MAN

THERE was completed at this laboratory on May 15 a successful 31-day experiment during complete inanition, the subject drinking 900 c.c. of distilled water per day. Elaborate measurements of the gross metabolism as indicated by the carbon dioxide production, oxygen consumption, water vaporized and heat elimination were made on each day. Continuous records of rectal temperature, pulse rate, respiration rate, ventilation of the lungs, blood pressure, microscopic blood examination, careful clinical examinations, anthropometric measurements and psychological tests were a part of each day's routine. Photographs of the subject at stated times and X-ray plates at the conclusion of the fast were secured. Complete urine analyses were also made throughout the 31 days. The mass of data will require several months for complete and verified computation.

Newspapers and magazines, actuated only by the sensational element, have used every means to secure advance statements, and in some instances have issued "faked" statements, regarding this experiment. The results will be presented only in the publications of the Carnegie Institution of Washington or in the regularly accredited scientific journals, and any prior statements purporting to be made by me or signed by the subject, A. Levanzin, are to be disregarded.

FRANCIS G. BENEDICT
NUTRITION LABORATORY OF THE
CARNEGIE INSTITUTION OF WASHINGTON,
BOSTON, MASS.,
May 15, 1912

## SCIENTIFIC BOOKS

*The Pines of Australia.* By RICHARD BAKER and HENRY G. SMITH. Technical Education Series, No. 16. Sydney, 1910.

The present publication of the department of public instruction of the state of New South Wales is a memoir of over four hundred and fifty pages, copiously illustrated by means of photographs and photomicrographs and accompanied by two maps showing the distribution of the "Pines." Many of the illustrations represent more or less accurately the appearance of stained microscopic sections reproduced by the three-color process. It seems questionable even in a semi-popular work like the present to use the term "Pines" to represent the Conifers as a whole. Such an appellation is almost sure to lead to misconceptions on the part of the reader, particularly in the southern hemisphere, where true pines are conspicuous by their absence. The authors are at some disadvantage on account of the multifariousness of the task they have set themselves, for they aim to include in their account of these trees, their systematic relations, the history of the names given them, their morphology and anatomy, their useful products, including the chemistry of some of these and finally their geographical distribution. This appears to be too large a field to be covered successfully or fully, even by the collaboration of a chemist and a botanist.

Under the head of morphology and anatomy are recorded observations as to the significance of the "spur" of the cone scale of the genus *Callitris* and the probable function of the central columella in the cone of the same genus. It is noted that the chemical products, particularly the resinous ones of species which resemble one another morphologically are very strikingly similar. Attention is called to the presence of manganese compounds in the parenchymatous cells of the wood of *Callitris* and other genera. The manganese content in some cases is very considerable. The value and nature of the tannins and sandarac resins of *Callitris* are discussed and similar accounts are given of the gums, resins and oils of the other coniferous genera of the Australian flora.

The volume concludes with appendices on the systematic value of the chemical products of plants, on the distribution of Australian conifers, and on the collaborators, who have assisted in various ways in the preparation of the work. There are likewise several good

maps which further illustrate the subject of distribution. The present work will be of considerable value to those interested in the economic products of Australia and to botanical travelers in that region.

*The Eusporangiatæ, the Comparative Morphology of the Ophioglossaceæ and Marattiaceæ.* By Douglas Houghton Campbell, Carnegie Institution of Washington, August, 1911.

This superb memoir deals with the representatives of two important orders of ferns, the Ophioglossales and the Marattiales, which on account of their remote and often tropical distribution are imperfectly known. The illustrations are admirable scientifically and are often extremely artistic. Thirteen full quarto page heliotypes representing the habit of the rarer species are of great beauty. While the author deals adequately with those features of the morphology of the Eusporangiates, which have been accessible to other writers, he naturally devotes special attention to the question of the structure and development of the gametophytes and the young sporophyte, since it is precisely in regard to these matters that our present knowledge is least perfect. With entirely admirable zeal, Professor Campbell has made it his business to visit those remote parts of our earth which are at the same time most interesting botanically and least salubrious and accessible.

An account as complete as is permitted by the abundant material rendered available by the author's extensive travels is given of the gametophytes of the three Ophioglossaceous genera, *Ophioglossum, Botrychium* and *Helminthostachys.* This is supplemented by descriptions of the development of the embryo and the later stages of the young sporophyte. It is clear that Professor Campbell inclines to the opinion that the leaf is the primitive fern organ and for him the genus *Ophioglossum* is likewise the primitive genus of the Ophioglossaceous family. There appears to be here much room for difference of opinion, since the whole tendency of investigation in recent years, covering both the living and fossil representatives of the lower vascular plants, whether cryptogamic or seed-bearing, has been to show that the course of evolution has been from the more complex to the simple and not as has been generally assumed in the past *vice versa.* Unfortunately in the case of the Ophioglossaceæ no fossil evidence is available to check up the results obtained from the study of the morphology of the living forms. In accordance with his point of view, the author apparently regards the stem of the Ophioglossaceæ as a complex of fused leaf bases, a conception supported in his opinion by the method of development of the vascular strands. He apparently regards the fertile segment of the leaf too, the so-called sporangiophore, as an organ *sui generis,* although Professor Bower, the most vigorous defender of this point of view, has recently practically abandoned it. The possibility of the sporangiophore representing specialized pinnæ of the leaf, which has recently been convincingly urged by Professor Chrysler, is not entertained.

The account of the Marattiales given by the author is particularly full and original and does full justice to the admirable opportunities of travel and collection which he has enjoyed. Of particular interest is the account of the gametophyte, sexual organs and embryonic development of the monotypic genus *Kaulfussia,* by reason of its marked resemblance to the fossil forms referred to the Marattiales. A feature of this second division of the memoir is the attention given to the development of the fibrovascular system. The author takes the position that the origin of the first tracheids as separate groups, which only later become merged in the general fibrovascular system of the stem, indicates the origin of the axis from originally separate parts. This doctrine carried to its logical conclusion would apparently lead to somewhat striking absurdities.

The third division of the memoir is devoted to the discussion of the origin and relationship of the two fern families described in the earlier pages. The author assumes the correctness of the antithetic hypothesis of the origin of the alternation of generations, char-

acteristic of all vascular plants. In this connection he definitely homologizes the moss sporogonium with the sporophyte of ferns. Obviously he entertains the view that *Ophioglossum* among the Ophioglossaceæ is probably the most primitive representative of the fern stock. There appears to be little support for the correctness of this view and it entirely lacks the confirmation of fossil evidence, which in this case is unfortunately lacking. Logically in accordance with the general attitude just indicated, the author derives the Marattiaceæ from ancestors allied to the Ophioglossaceæ. He acknowledges in this connection the serious difficulty of bridging over the morphological gap, between the dorsisporangiate foliar organs of the Marattiales and the so-called sporangiophore of the Ophioglossales. This difficulty appears to the reviewer to be very great indeed, especially in view of the known antiquity of the Marattiales and the apparently recent origin of the Ophioglossales. It further appears from a consideration of the reproductive parts and anatomy of the sporophytes as well as of the gametophytes, that it is much easier to derive the Ophioglossaceæ from typical ferns such as the Marattiaceæ, than it is to entertain the possibility of a reverse course of evolution.

*The Morphology of Gymnosperms.* By COULTER and CHAMBERLAIN. University of Chicago Press. 1911. Postpaid, $4.22.

The present volume is undoubtedly the most important general work on the gymnosperms which has ever appeared and is highly creditable to American science. It consists of four hundred and fifty pages and of an equal number of, for the most part, original and remarkably good illustrations. The book is characterized throughout by a sane, broad and withal interesting treatment. The views expressed as to affinities and evolutionary sequence are for the most part clearly, logically and convincingly stated.

The volume is modeled on evolutionary lines, grounded on the solid foundation of the testimony afforded by the rocks, and in this respect presents an agreeable contrast to most botanical works on plant evolution, which are too often written by persons who have no knowledge or appreciation of the past history of plants. In accordance with this feature, it begins with the oldest known seed-plants, the Cycadofilicales as the authors more logically term the Cycadofilices of Potonie and the Pteridospermeæ of Oliver and Scott. The enormous progress made in our knowledge of the evolution of the gymnosperms is nowhere better illustrated than in this chapter, which may be instructively compared with the meager amount of information supplied on the same subject in the first edition published ten years ago. Here we find an extremely good account of this fascinating primitive group of gymnosperms, long mistaken for ferns, whose true affinities were guessed at by the German paleobotanist Potonie and proved by Oliver, Scott, Grand'Eury and David White.

Logically following the Cycadofilicales, with the interposition of the Cordaitales, which need not be specially referred to in this connection, come the true Cycads and their allies the Bennettitales. The Chicago laboratories have added much to our knowledge of the Cycadales, and the chapter on this group of gymnosperms, now confined to the warmer regions near the equator, is one of the strongest in the book. The Bennettitales, the Cycads of the earlier Mesozoic, owe their elucidation to a large extent to the striking investigations of Dr. Wieland, of Yale University. We find them treated with the fulness which their importance demands.

Next to the Cycad-like gymnosperms come the relatives of the maidenhair tree, Ginkgo, sole survivor, through the pious care of the Japanese priests, of a stock which in the Mesozoic flourished abundantly throughout the northern hemisphere.

The Conifers, the most abundant and important gymnosperms of our existing flora and of great evolutionary importance on account of their extension into the remote past, appropriately occupy about one third of the volume. The gametophytes of this group, which have been particularly the subject of

investigation at Chicago, naturally come in for full consideration, but the past history and the important anatomical features of the Coniferales have not been overlooked. The great influence of modern anatomical and paleobotanical work is nowhere more clearly shown than in the systematic grouping of the Conifers along evolutionary lines. One illustration will serve to make this clear. In the first edition of the present work, which appeared ten years ago, the pine was considered to represent the highest member of the Conifers on account of the complexity of its vegetative and reproductive structures. In the present edition, it is put near the bottom, if not at the very bottom, of the coniferous series, since recent investigations, paleobotanical and anatomical, have demonstrated its great antiquity and at the same time the truth of the general proposition that the Conifers are a reduction series in which the simplest members are most modern and not an ascending one, in which the most complex representatives are the highest.

The Gnetales, which on account of their supposed affinities with the angiosperms are of great botanical interest, are adequately treated. The riddle of their existence is discussed in an entirely unpartisan manner. Following this chapter is one on evolutionary tendencies among the Gymnosperms. This part of the volume is naturally the one about which there is the greatest room for difference of opinion, and it is precisely here that the authors deserve the highest praise. At the present moment the older morphology is in process of resolution under the influence of experimental and paleobotanical activities. For that reason a clear expression of evolutionary sequence, even of groups concerning the past history of which we are well informed, as is relatively true of the Gymnosperms, is extremely difficult. Notwithstanding, in the present volume, we find a remarkably clear position taken, although not entirely unaffected by the back eddies resulting from the partial persistence of the older standpoints.

E. C. Jeffrey

Harvard University

*Pharmaceutical Bacteria, with Special Reference to Disinfection and Sterilization.* By Albert Schneider, M.D., Ph.D. Published by P. Blakiston's Son & Co., Philadelphia, Pa. Price $2.00.

The rapid development of bacteriology in various directions has led to the publication of books in considerable number, showing the application of bacteriology to different phases of modern life. Medical bacteriology, agricultural bacteriology, industrial bacteriology and various other aspects of this new science have been fairly well exploited. The present book is in a new line, and is designed simply to cover the relations of bacteriology to pharmacy—being intended primarily for students in college of pharmacy and incidentally to pharmacists in general. The subjects that are treated in the work are only those which have some practical relation to this business. After a general introduction there is a brief but comprehensive historical survey of the development of bacteriology, divided into periods and bringing the subject up to date. This is followed by a general description and classification of bacteria, with the method of bacteriological technique, and then brief considerations of the relation of the bacteria to a few industries, like agriculture in general, dairying, the extermination of pests, canning, cider-making, etc. A somewhat extended discussion of the problems of immunity and the activities of bacterial products, together with a discussion of the manufacture of sera and vaccines, is naturally given in a book of this nature, the subject being treated from both a theoretical and a practical standpoint. Disinfection and the use of various disinfectants are discussed quite extensively, the subject being considered from the standpoint of the disinfection of water, of food, of dwelling houses, of surgeons' supplies, of various chemicals that are liable to be handled in the pharmacy; in short, all relations of disinfection which have a bearing upon the problems of the pharmacy, are carefully considered. A chapter upon communicable diseases and their prevention treats very briefly of the

better-known bacterial diseases and the most modern preventive methods; and lastly a suggestion is given for the equipment of a moderate sized laboratory for the pharmacy.

The book in general is well written, well illustrated, and will be useful for the people for whom it is particularly designed. As a book on bacteriology for the general student, however, it is too narrow in its scope to be of any great value or interest. As its title indicates, it is a pharmaceutical bacteriology, and its place is simply in schools of pharmacy and in the hands of pharmacists.

H. W. C.

*The American Year Book. 1911.* Edited by FRANCIS G. WICKWARE, B.A., B.Sc. New York, D. Appleton & Co.

The American Year Book in its second issue presents a carefully collected and compiled record of events and progress, largely with reference to the year 1911. There are here gathered facts of use to writers of many kinds, covering many fields, scientific, somewhat aside from science, like history and politics, and others into which science is to-day entering, like economics and the social questions. Industries and occupations are considered under a number of grouped heads, while the sciences themselves and engineering are ranged in some seven groups. There follow the humanities, an epitome of chronology and necrology and some references to the volume of 1910, which, being the first, reviewed and outlined a number of subjects.

There are two criteria for determining the quality of a volume like this; one its actual fitness for the purpose for which it is intended and the other the list of contributors. The first-named can be reliable only after a season of trial, and the excellences or demerits may not be apparent on cursory inspection. Taking the list of names of the authors of the various essays, they should stand for a superlative product. It was Dr. Walter Wyman who prepared the article on Public Health and Hygiene, the revision after his death being done by Dr. Schereschewsky. There are here reviewed the world movements of epidemic diseases and the incidence and movements of the same within the United States. The writer does not fail to note in an authoritative way the measures of defense against the threatened invasion of cholera during the year, the unusual prevalence of smallpox, the improvement in the mortality rate of tuberculosis, the story of anti-typhoid vaccination, not forgetting a word of warning against measles and other diseases so common that no one fears them, yet which take large toll. In this connection it is interesting to note that the infant mortality can be given for eight states, only, Michigan being the sole one away from the Atlantic coast in which the registration is sufficiently good.

International statistics for world and country are presented from authoritative sources, government reports, local bulletins and the like. Some of the items are populations, national revenues and expenditures, products like cotton and wool, grains, coal and iron. These will be invaluable to persons needing such data. The international mortality rates given in the first grouping of figures is from an English source, the Registrar General's Annual Summary. It is curious that while taking places of as low rank in point of population as Stockholm and Bucharest, Prague, Trieste and Melbourne, the latter somewhere not far above 100,000, there are omitted such places as Tokio, Buenos Ayres, Liverpool, Warsaw, Manchester, Naples, etc., so that only about one third of the cities above half a million are represented. There must be better sources than that selected if full information is desired.

The third group, the Problems of Population, takes up many matters, one interesting one being the change in the shape of the head noticeable among the children of immigrants. For history there is a résumé of the political parties and their changes, some words on reciprocity and the tariff; conservation is considered and trusts and court decisions affecting corporations, etc. There is a good deal of space devoted to foreign history. Govern-

ment, national, state and municipal conditions are discussed at length; there is a consideration of economic conditions and labor questions, the items thus far occupying about half the bulky volume.

In matters of science the treatment is of rather restricted divisions, generally by those in the employ of the government or with colleges. In agriculture, Allen, Hooker, Evans, Knight and Glasson, all of them related to some bureau, discuss, respectively, the census of 1911, diseases of live stock, diseases of plants, legislation and horticulture, while Morse, of the Bussey Institute, considers live stock, and Felt, of Albany, the seventeen-year locust. Ethel Marion Smith, of the Bureau of Fisheries, takes up briefly the story of the fisheries. In similar manner Locke and Wilson, of the Massachusetts Institute of Technology, present reviews of mining and ore-dressing and coal, coke and petroleum, while Hofman, of the same school, discusses lead. Here no government expert is heard, but Fulton, president of the South Dakota school, Macgregor, of Columbia, and two engineers and an editor, Stoughton, Fulton and Ingalls, contribute other special articles. Mathematics in general is from the pen of Wilson, of the Massachusetts Tech, while Todd, of Amherst, writes quite at length and in an interesting manner of the astronomical world, outlining the important movements of the science. Geological topics are divided between Woodworth and Palache, of Harvard, Reid, of Johns Hopkins, who discusses vulcanology and De Wolf and Ransome. Meteorology of course is considered by Ward, of Harvard, terrestrial magnetism by Faris, in government employ, and in geography, Davis, of Harvard, is the only college man, Gannett and Littlehales, of Washington, and Adams, editor of the publications of the American Geographical Society, caring for the other sections. Chemistry enlists a full company of experts, Cornell and Columbia tieing the government number, two, with one each from Technology and Wisconsin, while the story of physics is presented by Saunders, of Syracuse. In the same way are taken up zoology, botany, paleontology, ethnology and archeology, the last three together by the presentation of abstracts of the books, publications and society achievements of the year. These notings will serve to show the method in which the subjects are attacked and the kind of men who have contributed the different essays. Psychology and philosophy, medicine and surgery and engineering follow, while religion, the arts and literature round out the whole.

The book is of convenient size, 8vo, well printed on light-weight paper, so that it is—despite its bulk of 900 pages—not inconvenient to hold in the hand, and it is quite well indexed by larger topics, which will probably serve the purpose since the articles are in general not long and are arranged with well-displayed headings.

John Ritchie, Jr.

## *NOTES ON METEOROLOGY AND CLIMATOLOGY*

### A NEW AEROLOGICAL LABORATORY

The close relationship between meteorology, the science, and aviation, the art, is becoming more generally recognized as time progresses. At present there is being erected at Rostock, a small city in northern Germany, on an arm of the Baltic Sea, an institution which is to be an aerological observatory as well as an aeronautical laboratory. The aerological researches will be based upon data obtained from aloft by means of kites and balloons, while the aeronautical experiments will consist mainly of the adaptation of aircraft to the conditions thus determined. Professor Otto Krümmel will direct the aerological investigations, while Captain Alfred Hildebrandt will have charge of the aeronautical work, which will include a manufacturing plant. Because of the favorable location especial attention will be paid to hydro-aeroplanes. As is customary in Germany, municipal aid will be given the new institution.

### THE NEW YORK METEOROLOGICAL OBSERVATORY

The New York Meteorological Observatory, located in Central Park, New York City, has

recently been placed under the supervision of the U. S. Weather Bureau. This institution, the first in the country to be equipped with self-recording meteorological instruments, was founded by Daniel Draper, Ph.D., in 1868. The expense of conducting the work of the observatory was provided for by municipal appropriations, while the founder remained the active director until his retirement a year ago. The meteorological record, exceeding in length that of the Signal Service and Weather Bureau, has been constantly referred to by a variety of interests in the development of the American metropolis. Under the new arrangement the Weather Bureau has two observatories in New York City. At the Central Park station observations are taken for the city by the federal officials just as was done when it was entirely under city supervision.

### ICE STORMS

WHEN rain falls while the temperature of the lower air is below freezing the drops solidify immediately after striking solid objects, and we have an ice storm—a frequent occurrence in the northeastern part of the United States. The precipitation continues in the form of rain when the temperature of the air near the ground is sometimes as low as 9° F., showing that there must be an inversion stratum but a short distance aloft, otherwise the condensation would result in the formation of solid particles rather than liquid drops. In New England, where these storms are particularly frequent, it is not uncommon for the ice to accumulate to a depth of an inch on all exposed objects, and on one occasion, February 14–16, 1909, ice was thus formed to a thickness of three inches in the suburbs of Boston, and did not disappear until four days after the storm had ended. The supposition that there is a relatively warm stratum aloft during an ice storm was verified by means of a kite flight at Blue Hill Observatory on March 7 last. In that flight the auxiliary kites added to lift the line became so heavily coated with ice that they pulled the leading kite down instead of aiding in its ascent, thereby rendering the maximum height reached during the flight considerably lower than usual. It was found that the air was practically isothermal from the summit of Blue Hill (200 meters above sea-level) to 625 meters above sea-level, the temperature being about 30.8° F. Beyond the latter level, however, the temperature increased steadily with height, and was 36.8° F. at 874 meters, the maximum height reached by the meteorograph. Raindrops falling from this relatively warm stratum were undercooled by their passage through the colder air below, and immediately changed to ice upon striking solid objects.

### EXTREME COLD IN THE UNITED STATES

IN persistence and severity the cold experienced in the central and eastern parts of the United States during January and February is noteworthy, as is seen from the following: At Grand Forks, N. D., the temperature fell to zero or below every day of January except the last, the lowest temperatures for all the days of the month averaging —20.0° F. At Washta, Iowa, —47° was officially recorded January 12. At Chicago, Ill., where the average daily deficiency was 11.9° F. the month was the coldest since the establishment of the Signal Service station there in 1871, and in unofficial records prior to 1871, extending back to 1830, the coldest January was 1.4° warmer than that of 1912. The mercury fell to zero or lower on 13 days, 10 of these being consecutive, and was continuously below zero for 79 hours during the 3d–7th, the longest period on record there. At Washington, D. C., usually a place of mild winter weather, —14° was recorded January 14, this reading being within 1° of the lowest temperature officially recorded there in 42 years, which is the length of the record. Some results of the extreme cold were unprecedented. For the first time since white man has lived in its vicinity Lake Superior was frozen over from shore to shore, the ice being of sufficient thickness to allow moose to cross from Canada to the American shore, according to press dispatches. For the first time in 28 years ice completely spanned Lake Michigan in places

on February 10. Lake Erie was also frozen completely across in some places. Since 1885 Cayuga Lake, in New York State, has not been frozen from end to end until last winter. Many important harbors along the Atlantic coast were kept open only by the ceaseless work of ice-breaking vessels, and for more than a week Long Island Sound was ice-covered, except for the narrow lane kept open by the frequent passage of steamers. Fire losses in the United States for the six weeks ending February 17 were the heaviest for a period of that length in the history of American underwriting, barring periods in which notable conflagrations occurred. The losses for January, 1912, were 67 per cent. greater than those of the same month a year ago, and 134 per cent. greater than those of two years ago. These facts are explained by underwriters as being largely due to frozen water-mains and hydrants, and to snow-blockaded streets, which handicapped the firemen. Doubtless the "oldest inhabitant" can recall many winters which were accompanied by considerably heavier snowfall, severer and more frequent storms and higher and more destructive winds than those just experienced, but few there are probably who can remember a longer period of frigid temperatures, with results similar to those cited.

### WINTER WEATHER IN FLORIDA

Florida, widely advertised as having "perpetual summer," or as one railroad puts it, "where every day is a June day," has been generally regarded as having a fountain of perpetual something or other ever since the days of Ponce de Leon. Its real climate, however, did not receive careful attention until large numbers of settlers were attracted by the recent land-boom. In A. J. Henry's "Climatology of the United States" it is stated that in 1886 and 1894 frost destroyed practically all citrus fruits in the state, and in 1895 and 1899 trees in the northern counties were killed in that manner. During the past century there have been at least seven severe freezes in the state, during two of which, 1835 and 1899, practically a zero temperature prevailed over the interior of the northern and western counties. Snow has fallen over the greater portion of the state, and on February 7, 1835, when a temperature of 7° above zero was recorded in Jacksonville, the St. John's River was frozen. A temperature of —2° F. has been recorded within the state. In all but eight of the last seventy years freezing temperatures have occurred in Jacksonville. January last, an extremely cold month over much of the United States, was also severe in Florida. The isotherm of freezing reached as far south as the middle of the peninsula on the 16th. At Miami, latitude 26° N., the most southerly city on the mainland of the United States, frost was recorded on February 11. As a winter resort contrast Florida with certain parts of California. According to official reports, 42° F. was the lowest temperature recorded during January at both San Francisco and Los Angeles.

### A STORM DETECTER

Reference has already been made in these notes[1] to the use of a wireless telegraph receiver to detect the approach of storms through the waves set up by electrical discharges. The idea was taken up by M. Flageolet, who has just invented an instrument of such acute sensitiveness that it records a storm at a distance of 300 miles. As it usually takes a storm about a day to travel this distance, the practical importance of the new invention will be considerable. The instrument was recently demonstrated before the Academy of Sciences in Paris by M. Violle.

### THE DISTRIBUTION OF RAIN IN CYCLONES

The distribution of rain in cyclonic storms has long been a problem of interest to meteorologists. As yet, however, all do not agree as to the region of heaviest precipitation with reference to the storm center. From early investigations it appeared that the rainfall was heaviest near the center of the depression, and became less and less toward the sides. Observations made at Blue Hill Observatory showed that clouds were densest and most fre-

[1] Science, Vol. XXXI., No. 807, June 17, 1910, p. 952.

quent in the southeast quadrant of a depression. Professor Waldo ("Elementary Meteorology," p. 221) says:

> In the eastern and northern parts of the United States the area of maximum rainfall lies southeast of the center of the cyclone, and usually at a distance of about 300 miles from it; but the distance varies greatly in individual instances.

In New England, however, the rainfall seems to be heaviest in the northeast quadrant of a cyclone, the precipitation accompanying a "northeaster," in which the center of the depression remains south of the observer during its eastward movement, is usually heavier than that of a storm whose center passes down the St. Lawrence Valley. Dr. Shaw ("Forecasting Weather," p. 206) seems to be of the opinion that the precipitation is most abundant, or at least is most frequent, in the "left front of the depression." In the latest discussion of the problem, Mr. F. J. Wardale (*Symonds's Meteorological Magazine*, February, 1912, p. 8) concludes that when a depression crosses England the bulk of the rain falls in subsidiary eddies on its northern side, the region of heaviest precipitation as the storm advances being "a broken band parallel to or gradually diverging from the central track on its left side." He believes that these eddies, too shallow to be evidenced on the meteorological charts, have a counter-clockwise orbital movement around their primary, at the same time sharing its forward movement. These eddies, in which the heavier downpours occur, pass quickly over and hence give slight precipitation to a place south of the storm track, for there they are accelerated by the general forward movement. For a place to the north of the center, the orbital velocity of the secondary is subtracted from the general forward movement, consequently the eddy passes slowly and in some cases might remain stationary, resulting in prolonged and therefore heavy rain. These eddies, he believes, are formed at intervals during the progress of the cyclone, thus accounting for the patchiness of the band of high rainfall. Mr. Wardale's suggestions are well worth the serious consideration of forecasters, since unnoticed secondaries and trough-like isobars have often resulted in heavy precipitation when fair weather was expected. His conclusions agree closely with those previously reached by Mr. W. G. Reed in a study of the cyclonic distribution of rainfall in the United States (*Monthly Weather Review*, October, 1911, p. 1609).

### NEW BOOKS

AMONG the books which have recently appeared are: (1) "Meteorology," by W. I. Milham. New York, The Macmillan Co. 8vo. 549 pp. $4.50 net. (2) "Weather Signs and How to Read Them, for Use at Sea," by W. Allingham. Glasgow, J. Brown & Son. 117 pp. 2s. net. (3) "The Sun," by C. G. Abbot. New York, D. Appleton & Co. 448 pp. (4) "Über die Helligkeit des Himmels in der Nahe der Sonne," by H. Diercks. Kiel, Lüdtke & Martens. 48 pp. (5) "Über die Gesetze der Wärmestrahlung," by W. Wien. Leipzig, J. A. Barth. 21 pp. 1 Mark. Among the books soon to appear are: (1) "The Meteorology of the Globe," by W. N. Shaw. (2) "Clouds," by C. T. R. Wilson. (3) "Structure of the Atmosphere," by C. J. P. Cave. (4) "Weather-science," by G. F. K. Lempfert. (5) "Radiation," by P. Phillips. Professor R. DeC. Ward has begun the preparation of a "Climatology of the United States."

ANDREW H. PALMER
BLUE HILL OBSERVATORY,
May 1, 1912

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## *SPECIAL ARTICLES*

### THE ORIGIN OF ERYTHROCYTES BY A PROCESS OF CONSTRICTION OR BUDDING

IT is gradually becoming apparent that in the solution of some of the more intricate morphological problems, involving phenomena of development and histogenesis, recourse will be necessary, in part at least, to data other than those obtained from fixed and stained preparations alone. Sabin, '05, in a discussion of evidence from fixed histological material bearing on certain questions regarding lymph-

ocytes and lymph glands has well expressed this conviction in the conclusion that "we must await some new method of attacking the problem." The recent development in the technique of tissue culture, with the striking results obtained by Harrison, Burrows, Lewis, Loeb and others, leads one to expect that similar methods may yield important data concerning the complicated problem of the life history and genetic relationship of the various types of blood cells. With this hope a study of the behavior of blood corpuscles in plasma cultures was begun somewhat over a year ago. Some of the results regarding the red blood cells appear of sufficient importance to justify a preliminary statement.

The present observations relate to the origin of the erythrocytes or non-nucleated red blood corpuscles and bear directly upon the long-standing question of the elimination of the nucleus. The description will be confined to certain results reached in a study of the blood of the pig embryo. Stating the method briefly, the erythroblasts of the embryonic blood were taken at various stages of differentiation and observed in hanging-drop cultures, employing the technique devised by Harrison and Burrows, with such modifications as appeared essential for the present purpose. Biased by the prevalent view that the nucleus of the erythroblast subsequently disappears, either by disintegration or by extrusion, it was hoped that it might be possible to observe the process directly in the living cell. It can be readily appreciated then with what surprise it was discovered that erythrocytes may arise in a manner fundamentally different from either of the above alternatives.

During the first half day (circumstances necessitated beginning the cultures in the afternoon) the erythroblasts manifest a variety of cytoplasmic activities, not inadequately described as amœboid in character. Numerous pseudopodia-like projections of various types are present. The greater number are in the form of tapering points or slender, elongated processes, varying from one to several in a given erythroblast. In a smaller number of cases the cytoplasm extends out in blunt, rounded, somewhat bud-like projections. These processes manifest constant quivering and oscillating movements. Other erythroblasts, spherical in form, are more or less quiescent. During the second day, of the above types of processes, the blunt bud-like form has become much more predominant. In other respects the cells appear as on the preceding day. These bud-like processes may involve one third or even more than one half of the cytoplasm of the cells. A striking feature is that not only are the buds completely filled with hemoglobin, but in many cases practically the entire hemoglobin content of the erythroblast has become segregated in the bud, leaving a more or less clear and hemoglobin-free cytoplasmic area surrounding the nucleus. If observations are begun upon the cell at this stage, the bud will be found in a state of amœboid activity manifested in changes in the contour varying from slight modifications to elongated projections. If the cell is at the height of its activity an astonishing thing may now occur: a constriction becomes evident and within a few minutes or even seconds this constriction is completed and the hemoglobin-containing bud is liberated from the cell. Typically this liberated bud corresponds in size and appearance with the adjacent erythrocytes; it may assume a bi-concave disc shape, and in one instance it was possible to continue the observations sufficiently to follow the final transformation of the liberated bud beyond this disc shape to a typical cup-shaped form. In each case control specimens of the blood originally employed for the cultures were fixed in formalin vapor and stained. Budding erythroblasts were also successfully fixed and stained and were found to correspond both in their cytoplasmic and nuclear characteristics with the control specimen. Erythroblasts were maintained in normal condition in several experiments for three or more days. Budding activities were continuous throughout this time, and under favorable conditions ten or more cells in various stages of active budding could be counted in a given field of the microscope.

When these remarkable activities were first observed it seemed incredible that we were witnessing a normal mode of erythrocyte formation. The experiments were consequently repeated many times, subjected to various tests, and the results analyzed in the light of all the criticism that could be brought to bear upon the subject. Temperature, media, evaporation, staining reaction and degenerative changes have been carefully considered. It is a pleasure to state that Professor R. J. Terry and Mr. C. H. Danforth, of the anatomical department, have also carefully followed these erythroblast activities and have kindly subjected the results to valuable criticism. In brief, after careful study the conclusion seems unavoidable that we are here confronted with a *normal mode of formation of mammalian erythrocytes by a process of budding and constriction from the parent erythroblast.* It is interesting that this result is in accord with the discarded theory of Malassez (1882), on the origin of erythrocytes from bone marrow cells by budding, while at the same time the investigations were made and the conclusions drawn entirely independent of any previous knowledge of his work.

In addition to the formation of typical erythrocytes, another type of activity consists in the production of either very small buds or slender, elongated, rod-like processes which may ultimately segment into a varying number of subdivisions about one third or one fourth the size of the average erythrocyte. These correspond very closely in size and form to blood platelets. As for the amount of cytoplasm remaining with the nucleus, after the constriction off of an erythrocyte, it may vary from a small rim about the nucleus to a quantity occasionally even larger than the erythrocyte to which the parent cell has given rise. No conclusive evidence of a migration of the nucleus from the cell has as yet been obtained. However, in the case of the smaller erythroblasts the constriction may take place so close to the nucleus that it may present the appearance of nuclear extrusion, and it is readily conceivable that in some cases the constriction may be such as to leave behind a practically cytoplasmic-free nucleus and thus account for the free erythrocytic nuclei occasionally found in the blood. That the fundamental process here described is one of cytoplasmic constriction rather than of nuclear extrusion is still further demonstrated by the fact that occasionally a single large erythroblast was observed to give rise to even two buds, both of which became detached from the parent cell.

Granting that we are justified in the above conclusion, various questions naturally present themselves; among others the behavior of the erythroblasts in different media; the factors involved in the formation of hemoglobin and its separation from the erythroblast; the subsequent assumption by the liberated globule of a disc or cup-shaped form; the fate of the nucleated remainder of the erythroblast, and the possible relationship between lymphocytes and erythroblasts. Investigation bearing on these problems is under way. The present preliminary statement will be followed as soon as possible with a full description of technique, detailed data, and figures upon which these conclusions are based.

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DEPARTMENT OF ANATOMY,
WASHINGTON UNIVERSITY MEDICAL SCHOOL,
April 25, 1912

## ON THE APPEARANCE OF ALBINO MUTANTS IN LITTERS OF THE COMMON NORWAY RAT, MUS NORVEGICUS

AFTER several failures to breed the Norway rats in cages, we have finally succeeded in raising them in captivity by means of an improvement in the cages and diet, as well as in general treatment.

This successful experiment was begun more than two years ago and we are just getting the litters which belong to the third generation born in captivity. It may be added that in all cases the brothers and sisters of the same litters were mated as I wished to determine the combined effects of close inbreeding and captivity.

The total number of rats belonging to the third generation born in captivity is not yet large. There are, however, six litters altogether, each having a different parentage. Within these six litters I have found four pure albino rats (white coat and pink eyes) among only brown-coated brothers and sisters. The distribution of these albino mutants within the litters is as follows:

(1) 7 brown and no albinos, born March 15, 1912.
(2) 6 brown and no albinos, born March —, 1912.
(3) 4 brown and 3 albinos, born April 17, 1912.
(4) 4 brown and 1 albino, born April 17, 1912.
(5) 12 brown and no albinos, born April 30, 1912.
(6) 5 brown and no albinos, born May 4, 1912. This litter was found dead; all had pigmented eyes.

Thus the number of albino mutants in proportion to the brown-coated brothers and sisters is not large, though it may increase in subsequent generations. Although I have been anticipating that such albino mutants might occur sometime, nevertheless it was a great surpise to obtain them within so few generations.

So far as I am aware, this is the first instance in which the albino mutants have been obtained from the common Norway rats under laboratory conditions and I thought the event of sufficient interest to justify this note.

S. Hatai

The Wistar Institute

## *SOCIETIES AND ACADEMIES*

### THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and fifty-eighth regular meeting of the Society was held at Columbia University on Saturday, April 27, 1912, with an attendance of fifty-two members. President H. B. Fine occupied the chair. The following new members were elected: Miss S. R. Benedict, Smith College; Mr. C. E. Fisher, Rhode Island Normal School; Dr. T. H. Gronwall, Chicago, Ill.; Mr. Louis A. Hopkins, University of Michigan; Dr. A. J. Kempner, University of Illinois; Mr. V. C. Poor, University of Michigan; Mr. R. B. Stone, Harvard University; Mr. K. P. Williams, Princeton University. Seven applications for membership in the society were received.

It was decided to hold the annual meeting this year at Cleveland, Ohio, in affiliation with the American Association for the Advancement of Science. The winter meeting of the Chicago Section will be merged in this general meeting of the society. Owing to President Fine's absence abroad, his presidential address will not be delivered at this meeting but at the annual meeting of 1913.

The following papers were read at the April meeting:

R. L. Moore: "Concerning Jordan curves in non-metrical analysis situs."

J. K. Lamond: "Improper multiple integrals over iterable fields."

L. A. Howland: "Binary conditions for singular points on a cubic."

B. H. Camp: "Certain integrals containing parameters."

S. Lefschetz: "On the $V_3^3$ with five nodes of the second species in $S_4$."

E. R. Marshall: "A labor-saving device in computation."

G. D. Birkhoff: "The reducibility of maps."

G. D. Birkhoff: "A determinant formula for the number of ways of coloring any map."

Oswald Veblen: "An application of modular equations in analysis situs."

H. B. Phillips and C. L. E. Moore: "A geometric use of matrices."

H. B. Phillips and C. L. E. Moore: "A theory of linear distance and angle."

L. P. Siceloff: "Sylow subgroups of groups whose orders are of certain special forms."

A. D. Pitcher: "Concerning the continuity and convergence of functions of a general variable."

W. R. Longley: "Proof of a theorem due to Picard."

A. R. Schweitzer: "Remark on a functional equation."

A. R. Schweitzer: "Theorems on functional equations."

Dunham Jackson: "On approximation by trigonometric sums and polynomials (second paper)."

N. J. Lennes: "Concerning Van Vleck's non-measurable set."

N. J. Lennes: "Concerning infinite polygons and polyhedrons."

The next meeting of the society will be the summer meeting, which will be held at the University of Pennsylvania, September 10–11.

F. N. Cole,
*Secretary*